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SILICON CHIP

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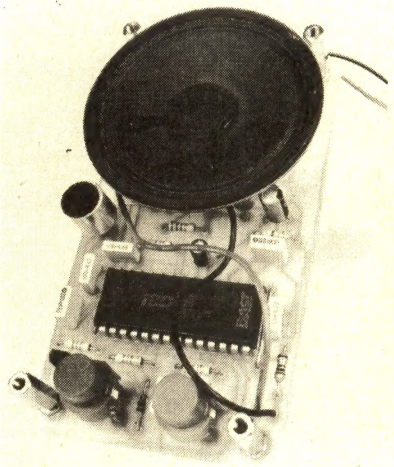
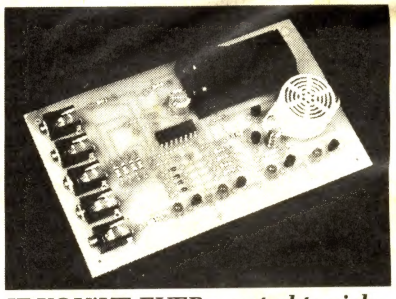
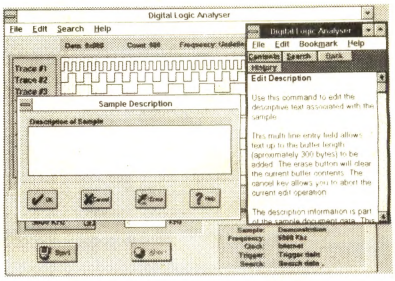


BASED ON A single IC, this project records up to 16 seconds of audio using a new sound chip that retains the recording even when the power is turned off – see page 32.



IF YOU'VE EVER wanted to risk all the prizes & go for the jackpot, then this is the project for you. It's called the Quizmaster & it will indicate which of four players pressed the button first.



DESPITE ITS APPARENT circuit complexity, the Digital Logic Analyser is easy to build. In Pt.2 this month, we conclude with details of the construction & software installation.

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PUBLISHER'S LETTER

Old textbooks & data books are valuable

Do you have old electronics data books and reference books that you are considering throwing out? Possibly they are taking up space and you haven't referred to them for awhile, so you now think you should throw them out. Think again, we say. At SILICON CHIP we have a policy of not throwing out any semiconductor data book even though we have later editions which ostensibly render them obsolete. The reason for not throwing the books out is that they are the only source of data on components which are no longer made. The new data books from manufacturers only feature devices which are currently being manufactured at the time the book was sent to the printer. If you routinely throw data books out, there is a strong chance you will regret it in the future when you need to refer to data which is no longer in print.

This problem is bigger than you might think. Currently, there are about one million semiconductors which are presently available and about half a million which are obsolete and this latter number is probably growing faster than the number of new devices being released. Even the most comprehensive data services tend to keep only short form data on obsolete semiconductors so once you throw a data book out, that's it; it's gone.

This tendency to throw out seemingly useless books extends to many TAFE, university and state libraries – they are running out of space and so they tend to throw out the older books which are now being referred to less often. We are appalled at this policy. We think that such libraries should regard older books as a valuable archive of technology as it was - the very foundations on which present day technology is based. If we throw out the older stuff, how are future generations going to know how much of our technology came about? More important, how can new and innovative technology be developed without a broad knowledge base, a base which is ultimately stored in the reference libraries across the country?

What can be done about it? First, think twice about throwing out old reference and data books – you might need them in future. Second, keep an eye out at your local reference library for books which may be on sale for a song. And third, indicate to your librarian that you think their policy of throwing technical books out is ill-advised and short-sighted.

Leo Simpson

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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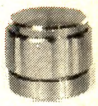

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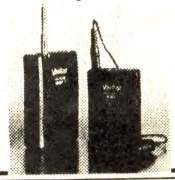

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The Keck observatory - biggest optical telescope

Recently commissioned on the Hawaiian island of Mauna Kea is the world's biggest ever optical telescope. At 10 metres in diameter, it is a great deal larger the previous biggest, the Russian 6-metre reflector. This is the story of the Keck Telescope.

Part 1: By BOB SYMES

The Hawaiian Islands, a group of eight main and about 130 smaller volcanic islands, are spread across approximately 2600km in the Pacific Ocean and they rise some 5,500 metres from the floor of the central Pacific Basin. The highest shield mountain of this chain, Mauna Kea, rises a 4,205 metres above sea level, thus leading to the claim that it is the highest mountain on earth, from base to summit.

The altitude, combined with the islands' remoteness from major centres of air pollution, and the prevailing NE trade winds, which combine to keep the weather relatively constant and the air clear and dry, were major considerations in choosing the site for an observatory complex.

A prime observing site can more than double the efficiency of any telescope. This is a most important consideration for any large telescope where returns in scientific knowledge need to be balanced against the huge costs involved.

After a world-wide survey of possible sites in 1963 by Gerard Kuiner, Mauna Kea stood out as the best place in the northern hemisphere for nighttime observation. The dry air at this altitude, where more than 90% of the atmospheric moisture is below the instruments, is critical for infrared observations, water vapour being the primary attenuator of radiation in this part of the spectrum.

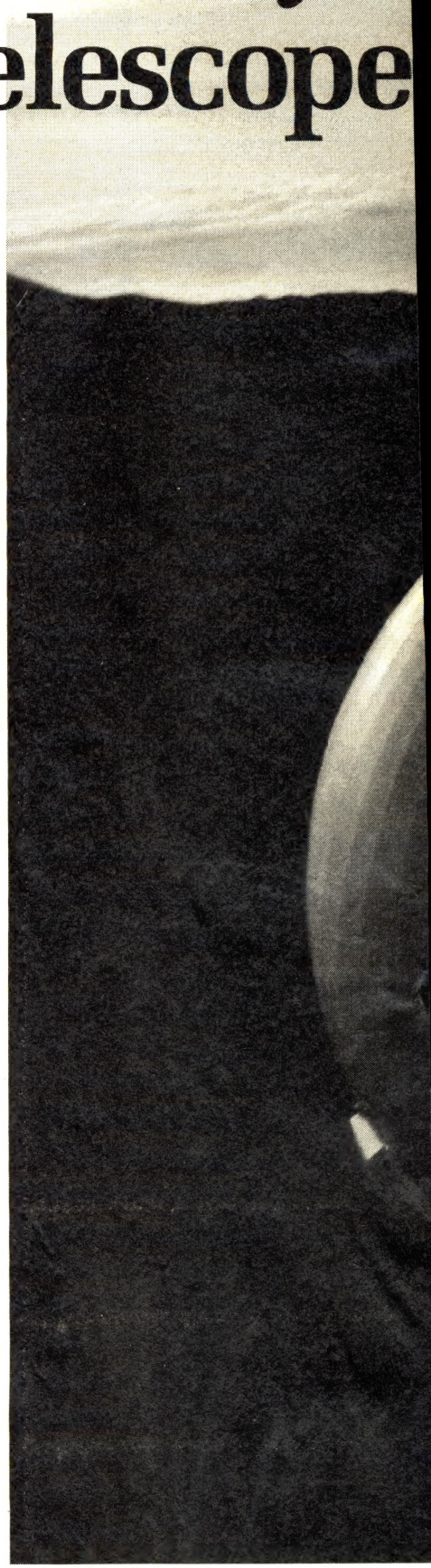
Furthermore, Hawaii has a relatively small population and industry is minimal. This leads to low light and industrial pollution. The island also has strict regulations affecting light pollution with particular emphasis on maintaining astronomical quality of the night sky.

The summit of Mauna Kea is usually above the inversion layer at night. The layer of clouds that often form below the summit on the windward side of the island as a result act as a further trap for light coming from Hilo 30km away. Gases and aerosols emanating from the occasionally active Kilauea volcano which can affect spectrographic investigations are similarly trapped by the inversion layer.

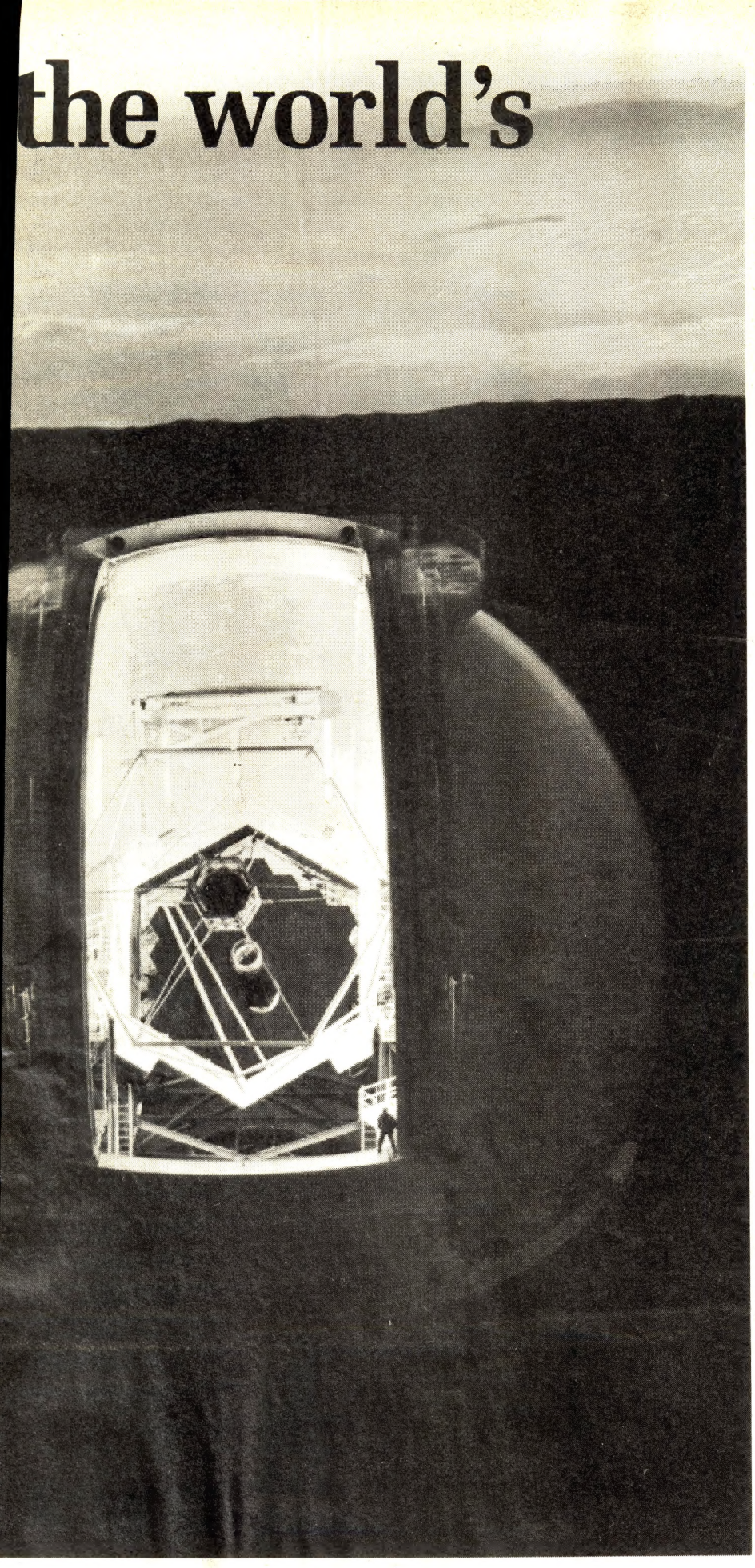
The stability of the air above the inversion layer provides exceptional optical resolution. The ultimate limitation to resolution on earth-based telescopes is air stability, which invariably reduces the theoretical resolution of the instruments themselves. On Mauna Kea, sub arc-second "seeing" is normal, and on nights of good air stability, resolutions of better than 0.5 arc-seconds are possible.

As a result of these considerations, the Mauna Kea Observatory was founded in 1967, in affiliation with the University of Hawaii. It has the distinction of being the highest observatory in the world.

While conditions at the summit are conducive to astronomical observa-



the world's



Taken under starlight, this photograph of the Keck Observatory, shows the enormous scale of the mosaic telescope which has 36 hexagonal mirror segments kept in alignment by computer control. Note the man standing at one side of the dome opening. Each mirror segment weighs 400 kilograms, giving a total mass of glass of 14.4 tonnes. The total moving mass of the telescope is 270 tonnes.

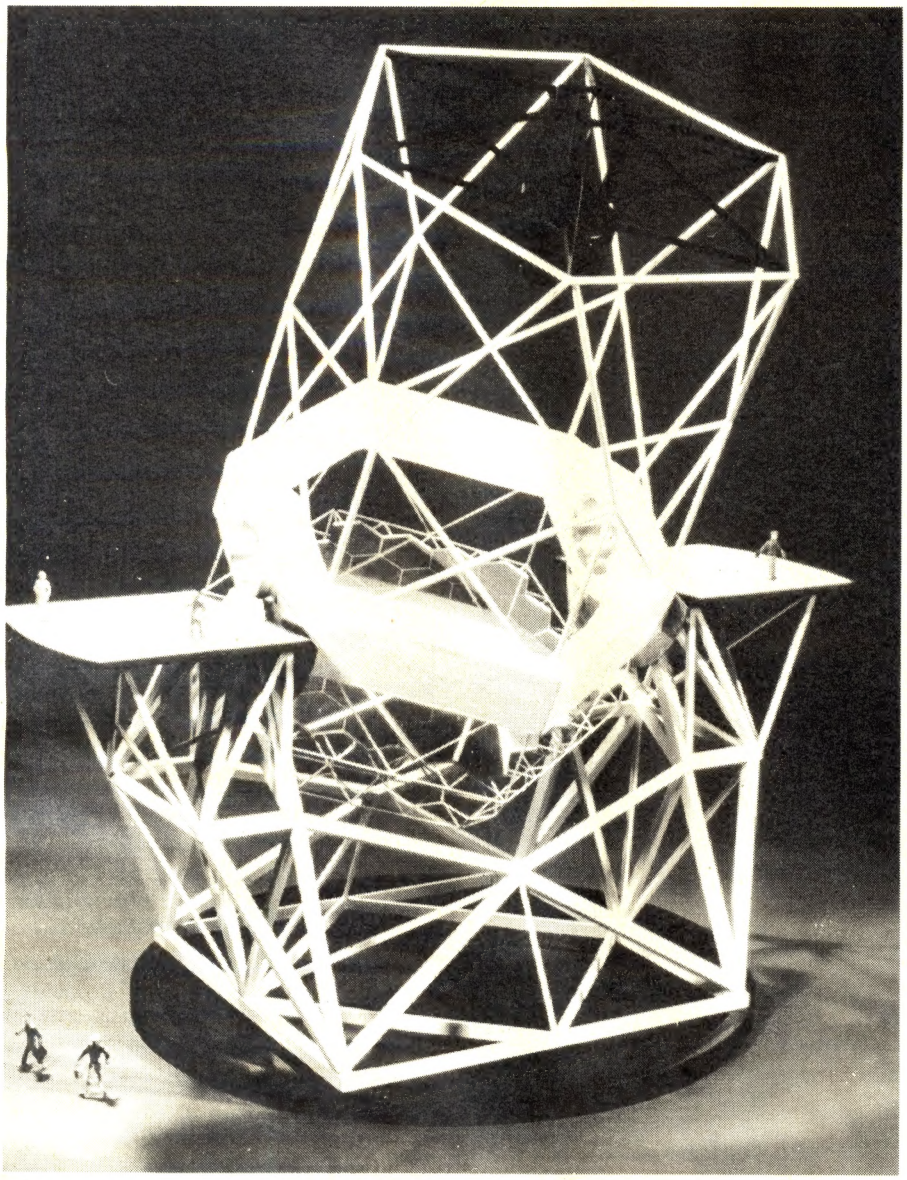
tions, they are not quite so good to the astronomers and technicians who operate the facilities. At times the weather can be severe, it is always cold, and oxygen deficiency may be a serious problem for some. For this reason, people intending to work at the summit need to acclimatise at a mid-level facility at Hale Pohaku (9300 feet – 2800m) which was constructed in 1982.

The University of Hawaii's Institute for Astronomy at the Manoa Campus in Honolulu leases the land above 12000 feet (3650m) from the state of Hawaii, and has dedicated it as a Science Reserve. In turn, the university provides site facilities for other observatories who wish to erect telescopes on the summit.

Currently, there are eight telescopes in operation on Mauna Kea plus one in the commissioning phase – the W. M. Keck telescope, the subject of this article.

Neglecting the atmospheric restrictions referred to above, the angular resolution of a telescope mirror (or lens) depends solely on its diameter and the wavelength being investigated. When the angular separation of two stars is very small, it might be imagined that by merely using enough magnification, the stars would resolve into two distinct images. Because of diffraction effects within the optics however, the image of each object is not a point source, but a so-called "Airy disc" whose diameter is $1.1\ \lambda/D$ radians, or $2.27 \times 10^5 \lambda/D$ arc-seconds (D being the diameter of the objective lens/mirror in centimetres).

If the two discs substantially overlap, any increase in magnification merely gives a larger blur of light, but does not result in separation of the images. The stars will be just resolved, however, when their Airy discs touch;



This model of the Keck telescope again shows the enormous size of the main mirror. It is much larger than most domestic swimming pools and with a focal ratio of f/1.75 (focal length divided by the diameter) it is deeply concave.

ie, when the centre to centre distance is equal to the diameter of the disc. Since D is the denominator, by increasing the diameter of the primary mirror/lens, the diameter of the Airy disc will be proportionately smaller, hence the resolution will increase.

Last century, the noted British amateur astronomer W. R. Dawes, working with close double stars, gave an empirical limit for the resolution of a telescope in arc-seconds as 11.5/D (the "Dawes Limit"). Strictly speaking, this figure is wavelength dependent, and refers to visible light of 5×10^{-5}cm. Since it is a rule of thumb rather than an exact physical formula, the difference across the visible spectrum is marginal, and can be neglected. Wavelength does become important however, when calculating the resolution in the infrared spectrum.

It follows therefore, where resolution is a factor, that the bigger a lens or mirror can be made, the better. The same goes for light gathering, although in this case it is surface area that is important rather than diameter. The two are not necessarily related. Doubling the diameter of a circular mirror gives four times the light-gathering power, and a doubling in resolution.

Since researchers are forever trying to look further back in time, this increase in light-gathering power becomes of great importance. The further away an object is, the further back in time we can look, since the light that we see left that object so much earlier in the history of the universe. But at those vast distances, the light reaching the earth is extremely feeble and the apparent size of the object is extremely small. So unless an instrument can be built that can gather as much of the available light as possible, and of sufficient angular resolution to show details of structure etc, little information can be gleaned from these objects.

Mirror problems

The simple solution is to make bigger monolithic mirrors or lenses. But the problems associated with them ultimately become insurmountable. Lenses supported only around their circumferences sag under their own weight. Once the sag becomes appreciable, image-quality deteriorates to a point where it becomes unusable. Thus it is unlikely that large lenses will ever again be used for astronomical work, although the existing ones still perform admirably. The largest of them, the 40-inch (1m) telescope at Yerkes Observatory at William Bay in Wisconsin, built by that most famous of telescope builders, Alvin Clark, and dedicated in 1897, is likely to remain forever the greatest of refracting telescopes.

Larger mirrors are easier to design and build, since they can be supported from the rear, and since only one critical surface has to be figured to high accuracy, as opposed to the four (or sometimes six) surfaces that need to be ground and polished for an achromatic objective lens. In addition, flaws such as bubbles, inclusions and striae in the glass of a mirror are acceptable, whereas they would be intolerable in a lens system.

Nevertheless, massive engineering problems remain. The larger a mirror becomes, the thicker it needs to be to avoid flexure and hence the heavier it becomes. The mounting becomes bigger and heavier, along with the cost, and finally there is reached a point at which further gains are no longer feasible. There is the additional problem that the more mass of glass there is, the longer it takes to reach thermal equilibrium, and during this time, image quality suffers due to local distortions in the mirror.

As new materials and techniques became available, the boundary of what was feasible was pushed further

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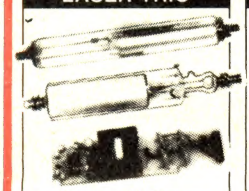

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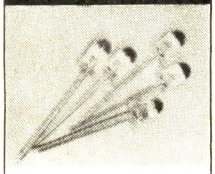

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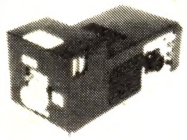
ARGON HEADS

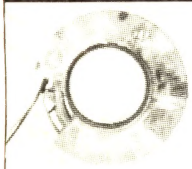


These low voltage air cooled Argon Ion Laser Heads are priced according to their hours of operation. They produce a bright BLUE BEAM (488nM) and a power output in the 10-100mW range: Depends on the tube current.

The head includes power metre circuitry, and starting circuitry. We provide a simple circuit for the supply and can provide some of the major components for this supply. Limited supplies at a fraction of their real cost:

$450-800

IMAGE INTENSIFIER TUBE AND NIGHT VIEWER KIT



These 18mm image intensifier tubes are similar to ones used in night vision equipment during the Gulf War. They are ex-military and may have some minor blemishes on the viewing screen. With suitable low light lenses they will produce good vision in as little as starlight illumination. The tubes require a 3V battery to make them operational.

$490 for the tube only

The viewer illustrated was made using some low cost plastic tubing and matching fittings, a low light camera lens, and an eyepiece. We can supply a custom machined kit of parts (Mostly aluminium) for our latest casing: This kit includes everything except the front lens and the battery. The eyepiece is included.

$98 for the case kit without the front lens

The lens we used is a 50mm "C" mount f1.4 video lens, for a 1" format (Cosmicar type: B5014A) and we will supply details of a supplier of this lens: Approx. $130.

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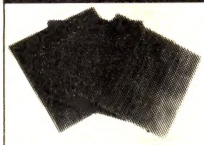

Use it to charge and or maintain batteries on boats, for lighting, solar powered electric fences, etc. Make your own 12V-4W solar panel. We provide four 6V-1W solar panels with terminating clips, and a PCB and components kit for a 12V battery charging regulator and a three LED charging indicator. See March 93 S.C. Incredible value!

$42

6.5Ahr. Panasonic gel battery $35. Electric fence PCB and all onboard components kit $40: See S.C. April 93. **The panels can be purchased seperately at $9Ea. or 4 for $32, or 10 for $70.**

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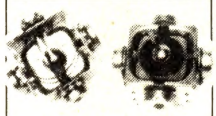

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For the 12V inverter kit and a visible red laser tube. The EHT generator kit is available separately for $23.

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We can also supply a similar kit which includes a laser diode, unmounted lens, and a driver kit **$39**

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We don't have much more information on these new components that appear of high quality. The tweeter alone is worth over $12.

8MM VIDEO CASSETTES

These 120 minute 8mm metal oxide video cassettes were recorded once for a commercial application, and then bulk erased. They are in new condition but don't have the record protect tabs fitted: The hole in the upper right corner will have to be taped over.

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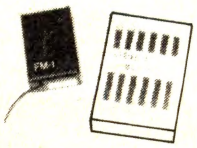
MINIATURE FM TRANSMITTER



Not a kit, but a very small ready made self contained FM transmitter enclosed in a small black metal case. It is powered by a single small 1.5V silver oxide battery, and has an inbuilt electret microphone. SPECIFICATIONS: Tuning range: 88-108MHz, Antenna: Wire antenna — attached, Microphone: Electret condenser, Battery: One 1.5V silver oxide LR44/G13, Battery life: 60 hours, Weight: 15g, Dimensions: 30 X 20 X 10mm.

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and further back. The 200-inch (5m) Hale telescope on Mount Palomar in southern California would not have been possible without the development of Pyrex, a low expansion glass which allowed the 14.5-tonne mirror to reach thermal equilibrium in time for the astronomers to still have some dark hours in which to do their work!

The development of air-conditioning and efficient insulating materials also helped by keeping the inside of the dome and hence the mirror at a constant average night-time temperature; ie, cold. Nevertheless, Mount Palomar seems to be about the largest size telescope that can be made using conventional mirrors and equatorial mountings.

Continuing the development of new techniques, the 6-metre BTA (Bolshoi Teleskop Azimutal'ny = Large Altazimuth Telescope) on Mount Pastukhov in southern Russia was the first large telescope to use an altazimuth mount instead of an equatorial, since the equatorial would have been too massive to control accurately, and too costly to build.

But the advent of the altazimuth mount had to await computers with sufficient power to control the continually changing position of the telescope, since the calculations to move each axis are far more complex than the requirements of an equatorial mount, where (more or less) the drive has only to be able to rotate the polar axis at the sidereal rate. Altazimuth telescopes have the additional complexity of field rotation during observation, a problem not encountered with equatorial mounts. Further computing and mechanical complexity is involved in resolving this problem.

The type of glass used in a telescope mirror has a great bearing on the ultimate size that can be produced. Ordinary borosilicate glass is easy to cast in large sizes and to stress relieve after casting, but thermal expansion is so great that it is unusable in this role.

The development of Pyrex, in reducing thermal expansion to tolerable limits, enabled much larger mirrors to be contemplated, but casting an homogenous blank was far more difficult, and it had a tendency to crack when being stress-relieved, a process that often took months or even years of slow cooling. Fused quartz has been used successfully but the extreme difficulty of making large blanks has limited its use on very large telescopes, as has the development of new and better materials.

As each new glass was developed, the rewards in temperature stability were greater, but so were the problems of manufacture. Cervit and its Soviet counterpart SITAL (used in the replacement mirror for the 6-metre telescope) were the first successful attempts to make a complex ceramic-glass mixture, where the coefficient of expansion of the ceramic almost exactly countered the opposite coefficient of expansion of the glass.

This was taken a step further with the development of Zerodur by Schott of Mainz, Germany. After initial casting, careful control of the subsequent stabilising/stress-relieving thermal cycle results in a glass in which half of the mass is cryptocrystalline and half is a supercooled liquid – the so-called "ceramization" process. Again, the coefficients of expansion of the two phases are equal but opposite and closely cancel each other out.

The worst example of thermal problems in a large telescope came with the original 42-tonne pyrex-like primary of the BTA, where a change of no more than 20°C per day in glass temperature could be tolerated and still maintain a useable figure during night-time observing runs.

The next development was that of thin-mirror telescopes. Usually, the thickness:diameter ratio of the glass blank is between 1:6 to 1:8. As mentioned before, these larger mirrors become inordinately heavy and need to be supported by inordinately massive mounts, and the problem of pointing finesse and controllability as well as thermal equilibrium considerations again dictate limits. Thus was born experimentation and successful implementation of thin-mirror technology, with thickness:diameter ratios of 1:10 to 1:25. These were made possible by the rigidity of the newly developed glasses, and by casting the blanks so that they tapered in thickness from the centre out, as well as having anti-flexure webs incorporated on the rear of the mirror. This went a great way to reducing the problems associated with weight, flexure and thermal equilibrium.

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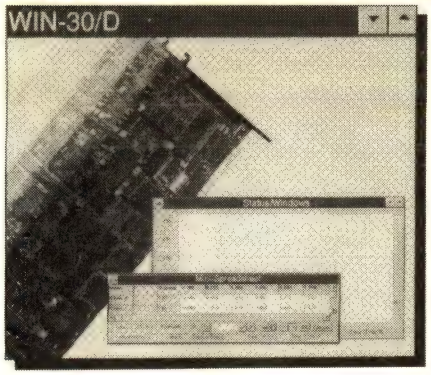

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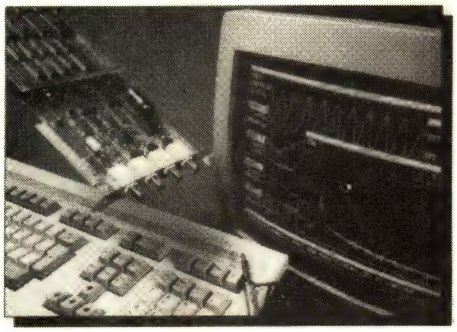

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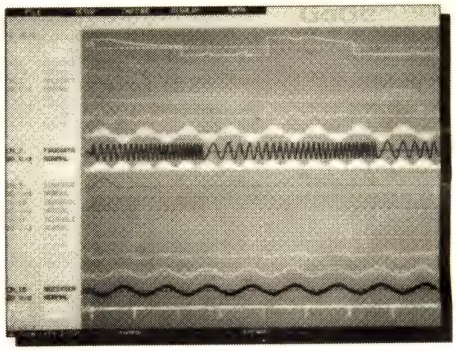

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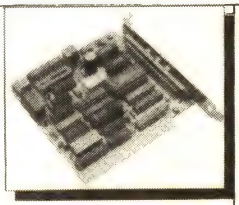

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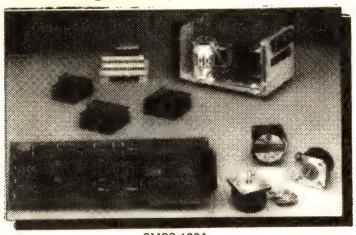

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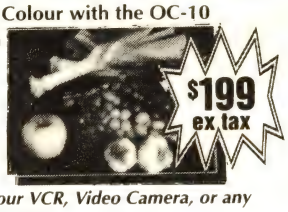

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As each of the above problems of large mirror making were more or less, successfully solved, even larger mirrors became feasible. But there remained one difficulty that couldn't be reduced easily – that of the actual figuring and final polishing of the reflecting surface itself. It is generally agreed amongst optical engineers that doubling the diameter of a mirror makes it 10 times more difficult more difficult to grind.

The amount of material to be removed is significantly greater, and the final zonal corrections are fraught with time-consuming difficulty. If one zone is high, it only has to be polished down to specification, but if it is low, the entire surface has to be polished down to accommodate the low spot. Even though we are speaking of microns, the work involved in polishing down a large mirror is massive. And always bearing in mind that not only does the final figure have to be good, but the focal point cannot be changed by any corrections or re-figuring, as by this time the structural engineering side would be well on the way to designing and building the mounting, which by now cannot be changed.

There is also a trend to design large telescopes with very fast optics, often less than f/2. Firstly, this gives the observer a much brighter image to work with, albeit at a reduced image scale. Also, the supporting structure can be much lighter because of the shorter tube involved and significant savings can be made in the design and construction of the dome.

Two techniques are successfully used today to partially overcome the difficulty of grinding and polishing mirrors to the required shape. Virtually all telescope mirrors have a paraboloidal or hyperboloidal cross-section and the traditional technique is to first grind it to a spherical surface, and then after testing for the sphere by traditional optical means, to parabolise or hyperbolise the surface by deepening the centre with a sub-diameter polishing lap.

The first new technique is a computer controlled polishing engine, usually combined with a laser profilometer feeding back to the controller. It has the advantage of good accuracy and is much quicker and less labour intensive than manual polishing. Since large mirrors are so seldom made, the computer polisher is usually made as a one-off special for that particular mirror and this adds substantially to the cost, speed of execution notwithstanding.

The second new technique is known as spin-casting. Glass is melted in an electrically heated mould and held for a time to soak so as to remove as many bubbles and other imperfections and inclusions as possible, and then spun whilst cooling to produce the required paraboloidal shape. The mould also incorporates a honeycomb base which creates a lightweight blank. The resulting curved blank dramatically reduces the amount of material that has to be removed and hence the time to attain the final figure.

Several large astronomical mirrors in the 6-metre to 8-metre range have been cast successfully with this method, although at least three (8.2-metre blanks for the European Southern Observatory's Very Large Telescope –VLT) have cracked and have been destroyed in the annealing stage.

A final technique that had been discussed theoretically for years is that of stressed mirror polishing. In effect, the mirror blank is deliberately distorted to a predetermined shape and then polished to a spherical section by conventional methods. After final polishing, the distorting forces are removed, and the mirror takes up (hopefully!) the desired shape.

The greatest proponent of this new method was Jerry Nelson of the University of California. In the late 1970s he proposed that large astronomical mirrors could be produced this way. He made a further proposal, one that was to have a great bearing on the design and building of modern telescopes – that large mirrors be made of multiple segmented smaller mirrors rather than one large blank.

The idea of segmented mirrors to avoid the weight problem and the increased complexity that accompanies figuring large single mirrors is not new, having been discussed by the third Earl of Ross in the mid 1800s. In the late 1940s, Horn-d'Aturo in Italy actually made a 61 hexagonal-segment mirror. This formed a 1.8-metre f/6 telescope that gave good images, although it was unsteerable.

With the previously discussed years of telescope design, glass making and polishing technology, and adequate computing power, the stage was set for the development of the most ambitious optical device ever built, the 9.82-metre W. M. Keck telescope.

The driving force behind the radical new telescope was Jerry Nelson. He spent a great deal of time convincing the pundits that such a project was feasible, since nothing on this scale had ever been tried before. From the start, the concept and design were revolutionary. New methods had to be devised to construct mirror segments, the warping harness, support structure, actuators, and the computer programs that brought them all together.

The segmented mirror design on such a large telescope was novel, and there was no previous experience at this scale to draw on. The mount would have to be rigid enough to keep the segments in exquisite alignment but light enough to gain from the benefit of such a design. The electronics to sense and correct misalignment had to be developed from scratch. Even the grinding and polishing of the mirror segments themselves were to use new and untried techniques.

In all facets, innovative thinking and methods had to be employed. And all this had to come together at the top of a windswept mountain where the air is so thin that the engineers and construction workers had to contend with dizziness, forgetfulness, headaches and dehydration, while solving the engineering problems that would be inevitable with such a massive undertaking. **SC**

All this had to come together at the top of a windswept mountain where the air is so thin that the engineers & construction workers had to contend with dizziness, headaches, forgetfulness & dehydration.

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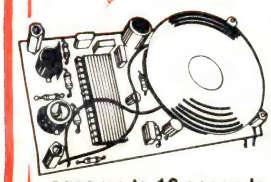

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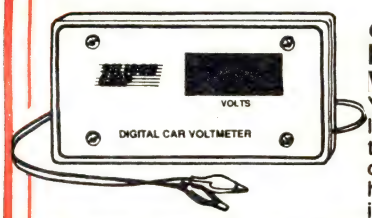
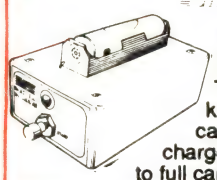


Gearing up For Winter!

DIGITAL VOLTMETER FOR CARS

Your car's battery is the most likely component to fail during the winter months. With this digital voltmeter you can see how your car's battery is faring in order to avoid all the hassles that come with a flat battery. Using an older, but far more economical, circuit technique than most digital voltmeters, it accurately measures the battery voltage over an 8-17 volt range and displays the result on a 3-digit LED display with 0.1V resolution. If the battery voltage is less than 12V, then either the charging system is not working correctly or the battery is dead! The voltmeter also warns you if the battery is being over charged, helping you to avoid damage to both your battery and engine. Comes in full form with all components, PCB, case, front panel label & digital displays. Also a satellite PCB is supplied if you wish to mount the displays remotely.

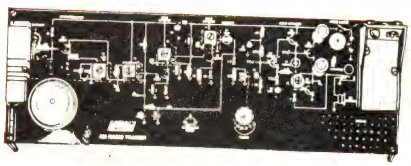
Cat K-4208 — June '93 — **NEW $39.95**



NICAD BATTERY DISCHARGER

This inexpensive single cell NiCad discharger kit is the best way to get maximum life and capacity out of your NiCads. It will correctly discharge any NiCad cell so that it can be recharged to full capacity. Discharges AAA, AA, C or D cells down to 1.1V and then turns itself off automatically. It's easy to build and it's powered by the cell it's discharging. Plus, it has reverse polarity protection and a flashing LED to indicate discharge. Comes with all components and hardware including PCB, 'AA' battery holder, alligator clips, zippy box and front panel label.

Cat K-3128 — May '93 — **NEW $24.95**

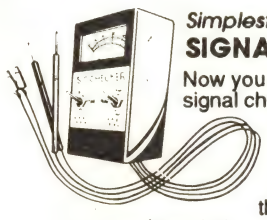


Ideal Learning Aid!

READY-TO-BUILD AM RADIO TRAINER

Teaches you, your kids or your students the basic principles of how a superheterodyne radio works. It's built with easy-to-get parts and everything is mounted on a single PCB with the circuit diagram screened onto the component side of the PCB so assembly is a breeze. Supplied with all components PCB and hardware.

Cat K-5016 — July '93 — **NEW $39.95**



Simplest Signature Analyser Yet!

SIGNAL CHECKER

Now you can build your own simple cost-effective signal checker! Without being as complex as traditional models, this compact version can compare circuits point by point. If you have a faulty board and a good board for comparison, you can easily find the bad components that are out of spec and repair the board. The Signal Checker integrates the magnitude of the difference between the signature of a good component to that of a bad one and displays it on a meter reading. Operated by one 9V battery (not included) and comes in full form, with all components, hardware bits, panel meter, PCB, zippy box, pre-punched silk-screened front panel and test probes.

Cat K-7226 — July '93 — **NEW $39.95**

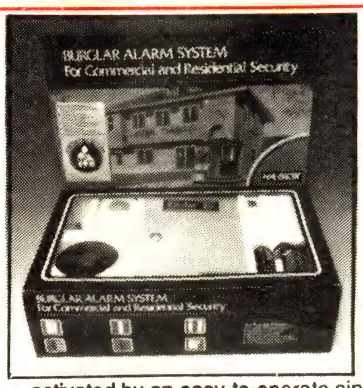
Outstanding value!

LOW COST NOISE AND DISTORTION METER

For most of us, it's not difficult to measure noise and distortion - it's either too loud or it's not! But for anyone involved with audio equipment, this noise and distortion meter is a must. It can measure distortion levels down to less than 0.01% at spot frequencies of 100Hz, 1kHz and 10kHz. It provides a built-in low-distortion meter and AC millivoltmeter at a fraction of the cost of commercial models. Although you can test frequency response using an audio oscillator and oscilloscope, you really can't check output distortion. With this meter you can quickly and easily measure the THD for a much more reliable indication of a circuit's performance under steady-state conditions. It has its own built-in reference oscillator and delivers more than credible performance at very low cost. Comes with all components including hardware, panel meter and deluxe case with pre-punched silk screen panel.

Cat K-7222 — June 93 — **NEW $129**

Please contact your nearest store for availability as some kits may still be in production.



Big Protection On A Small Budget!

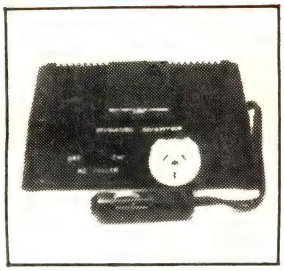
AFFORDABLE HOME SECURITY SYSTEM

You don't have to spend a fortune to protect your home! Security is yours with this affordable system - it covers the average home and can be easily upgraded to suit your future requirements. It's activated by an easy-to-operate single key, includes a passive infrared sensor (PIR) for area surveillance, five pairs of magnetic switches for use on doors and windows, plus a panic button that trips the alarm instantly, an external horn siren and plug in power supply. You can install it yourself using the easy to follow, step-by-step instructions supplied.

Features:
- High quality 3-sector alarm panel
- Easy-to-use 1-key activation
- Passive Infrared area sensor
- 5 pairs of magnetic switches for windows and doors
- Panic button and mains power adaptor
- Comprehensive, step-by-step installation instructions

Cat L-5142

NEW
$229



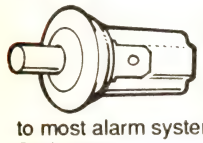
12-240V 200W INVERTER

A compact, advanced power system providing 230V AC from a 12V DC source. It will operate most low powered, electrical equipment, including smaller televisions and VCRs, personal computers, small kitchen appliances and cam-corder and cellular phone chargers.

DC input Input Voltage:	10.7-14.5 (12V nominal)
AC Output Voltage:	230V RMS
Output Frequency:	400W (surge), 200W (40 minutes), 160W continuous
Dimensions:	182(h) x 105(w) x 60(l)mm
Weight:	1.1kg

Cat M-5010

NEW **$249**

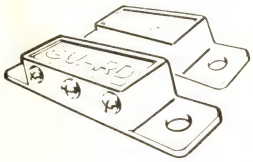


ALARM TAMPER SWITCH

Ideal for protecting alarm panels and siren covers - it detects if they've been tampered with and triggers the alarm. Can be mounted to most alarm systems on a normally-closed circuit.

Cat L-5286

$2.95



REED SWITCH

With both N.O and N.C contacts. For easy mounting, it is encased and double-sided tape and screws are provided.

Cat L-5211

$5.95

NEW

SAFETY SWITCHES

Ideal for the work bench or for domestic appliances. These safety switches prevent electrocution by automatically cutting off power from your appliances within 30 milliseconds. 10A rating.

Unit that wires to existing cord.

Cat M-7291

$29.95

Simply plugs in.

Cat M-7292

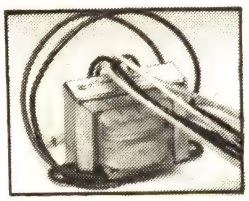
NEW **$39.95**

LATEST RELEASE! NEW TRANSFORMERS.

30V CT + 36V CT @ 140mA TRANSFORMER

Secondary Voltage: 18-15-0-15-18V
Secondary Current: 140mA
Terminations: Flying Leads
Dimensions: 35(h) x 44(w) x 42(d)mm
Cat M-2856

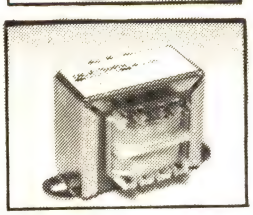
$8.95



30V CT + 15V CT@ 500mA TRANSFORMER

Secondary Voltage: 15-7.5-0-7.5-15V
Secondary Current: 500mA
Terminations: Flying Leads
Dimensions: 50(h) x 61(w) x 44(d)mm
Cat M-2860

$14.95



6.3-15V @ 2A TRANSFORMER

Secondary Voltage: 6.3, 7.5, 8.5, 9.5, 12.6 & 15V
Secondary Current: 2A
Terminations: Solder Lugs
Dimensions: 60(h) x 70(w) x 68(d)mm
Cat M-2156

$16.95

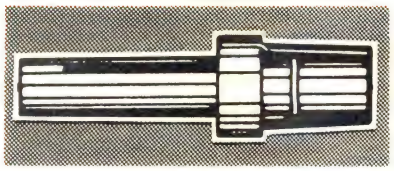
Excellent Value For Your Money!

AUTO/BOOST 6A BATTERY CHARGER

A rugged battery charger with an easy-to-read LED display. Suitable for 12 volt batteries used in cars, caravans and boats. It has an automatic charging mode to hold batteries at full charge and a condition analyser function.

Cat M-9806

NEW **$69.95**

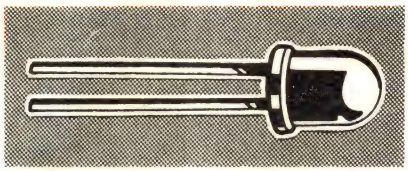


INLINE 3AG FUSE HOLDER

A 12 volt fuseholder just like our standard P-7912 but this one has no cable attached. All necessary connecting hardware (contact studs, tension spring) are included. Simply add your own wire!
Cat P-7911

NEW

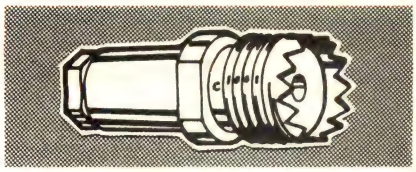
85¢



5mm ROUND BLUE LED

Light up your panel with a blue LED. Rated at 3V 30mA and at a low price!
Cat Z-4005

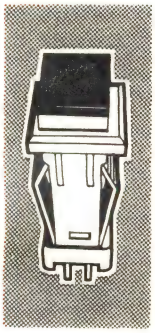
$3.25



INLINE UHF SO239 SOCKET

With gold flashed centre and teflon insulation. To suit RG58C/U and RG59/U.
Cat P-2320

NEW **$6.95**



Switch On!

MINI SWITCH

A new square push-on/ push-off switch with flat top. It's 11 x 12.5mm with a clearance depth of 32mm and an electrical rating of 240V AC. @ 1 amp.

Black Cat P-7540
Red Cat P-7542

$2.95

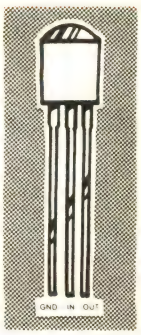
Have you tried our new range of Multilayered Polyester Film MKT Capacitors yet?

They are all rated at 100V 5% (except for the 1.0mfd & 1.5mfd, rated at 63V 10%) and they offer high quality in a small package with a uniform leg spacing of 5.02mm. From the French company -SGS-Thompson, these capacitors allow you to construct circuits that are far more compact than the normal 'Greencaps'. Values from 0.001mfd to 1.5mfd are available at all Dick Smith Electronics stores.

RADIO/TV/RF

MK 484 AM Radio Receiver, T092. Similar to the ZN 414 and available at a lower price than in 1989! See your nearest store for data!
Cat Z-6525

$3.95
10 Up **$3.36**



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Weller are well established and much respected manufacturers of top quality tools. As we are one of their key distributors, Dick Smith Electronics stock a comprehensive range of Weller tools and accessories. You can be assured that if you require any Weller product that is not in stock we will order in on request. Plus, we offer wholesale pricing for major customers through our commercial division. Here is just a sample of our Weller range - come and see us at Dick Smith Electronics for more!

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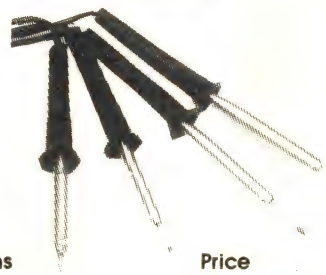
WELLER WTCP SOLDER STATION

$179

Weller is the first choice of many hobbyists, technicians and service people. Design features such as the non-burning silicon rubber soldering pencil lead, long-life iron plated tips, lock slots on both sides of the soldering iron stand and wick fed tip cleaning sponge make Weller a name you can trust. 48W Max, 24V output
Cat T-3000

MARKSMAN SOLDERING IRON

A top quality range of general purpose Marksman soldering irons suitable for light range to heavy soldering work. They are mains powered and incredibly efficient with impact and heat resistant handles and replaceable nickel and iron plated tips. They also feature stainless steel barrels and ceramic filled elements for greater stability.



Watts	Irons	Price
15W	Cat T-1310	$32.95
25W	Cat T-1400	$49.95
40W	Cat T-1404	$54.95
80W	Cat T-1315	$64.95

NOTE: 120W,175W & 250W Irons are available by order

WELLER EC 1001D SOLDER STATION

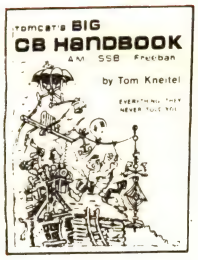
$299

The ultimate in controlled temperature soldering. A high quality mains powered soldering station. The tip temperature is electronically controlled between 177°C and 454°C and calibrated to within 6°C. A platinum sensor, ensures dynamic response to load variation and a thryistor drive eliminates high voltage spikes or magnetic fields from the tip. Plus, other safety features ensure safe soldering for sensitive and expensive electronic circuits. Complete with power unit and inbuilt transformer, soldering iron, cleaning sponge and detachable iron holder.
Cat T-3050

Get Into Radio!

CB HANDBOOK

Tom Kneitel



$39.95

The world's most widely read CB expert's guide to AM and SSB CB operations. This 221 page, fully illustrated book tells you how to get the most from your CB. Includes CB Handles; their meanings and uses, the best operating techniques for AM, special SSB protocol, a complete CB jargon dictionary, equipment, troubleshooting and more. The one book all CB'ers should own!
Cat B-2500

WORLD RADIO TV HANDBOOK 1993

Save $5

$34.95

(June only)

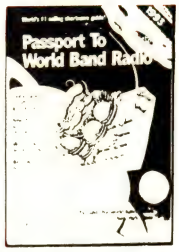
The ultimate directory of international radio and television. Gives complete listings including frequencies, addresses, call signs station identification and transmission times. There's even a special feature on how to convert local time against UTC.
Cat B-2093

PASSPORT TO WORLDBAND RADIO '93

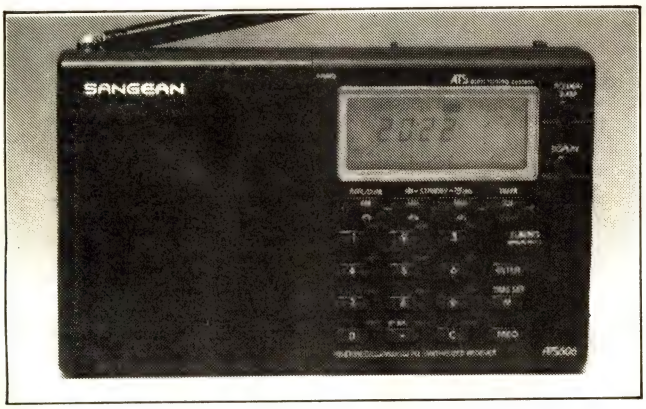
Save $5

$34.95

(June only)



This book is imperative for anyone who's getting started with a shortwave receiver. It's the latest 1993 edition and it includes all the changes that have taken place in Europe and Russia. If you want to know what's on shortwave radio, the best and worst radios, how to get the most from your shortwave listening and more, it's all here.
Cat B-2052



With Auto Tuning!

COMPACT 45-MEMORY SHORTWAVE RECEIVER

SANGEAN

Listening to the world on shortwave radio has never been easier! The super compact ATS-606 from Sangean makes finding your favourite shortwave (and local) stations as easy as pushing a button. Let it scan through the bands for you or, with the new Auto Tuning System (ATS), it will locate and put the nine strongest signals on both the AM and FM bands into memory. You can also key in a stations frequency directly from the keypad or put up to 45 frequencies into memory for instant push-button access. It gives continuous shortwave coverage from 1.715-29.995MHz, and 13 international SW band divisions can be directly accessed at the touch of a button. There's an informative back-lit LCD screen showing frequency and time with a variety of icons to indicate the functions being accessed. You also get a dual alarm clock, sleep timer, dual time settings so you can pre-set any two time-zones, DX/local switch which allows you to set the sensitivity to suit differing conditions, and a lock switch to prevent accidentally changing stations. Comes with stereo earphones for FM stereo operation and has an antenna socket for connection of an external antenna. Requires 3 x AA batteries.

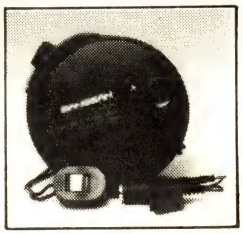
Features:
- Automatic tuning system
- 45 station memories
- Comprehensive LCD screen
- Scan tuning & direct keypad tuning
- Dual alarm clocks
- Dual time setting
- Adjustable sleep timer
- Soft carry case

Frequency ranges:
FM: 87.50-108MHz
LW: 153-513kHz
MW: 522-1710kHz
SW: 1.715-29.995MHz

Includes 13 pre-set shortwave bands
Cat D-2847

$249

PORTABLE SHORTWAVE ANTENNA



Want to boost the performance of your portable shortwave radio? Then you need one of these: The Sangean ANT-60 is a wind-up reel-style antenna that extends to a full 7 metres (23ft), yet fits in a shirt pocket! It connects via a 3.5mm mini plug or the supplied adaptor that clips onto your portable's telescopic antenna.
Cat D-4400

SANGEAN **$19.95**

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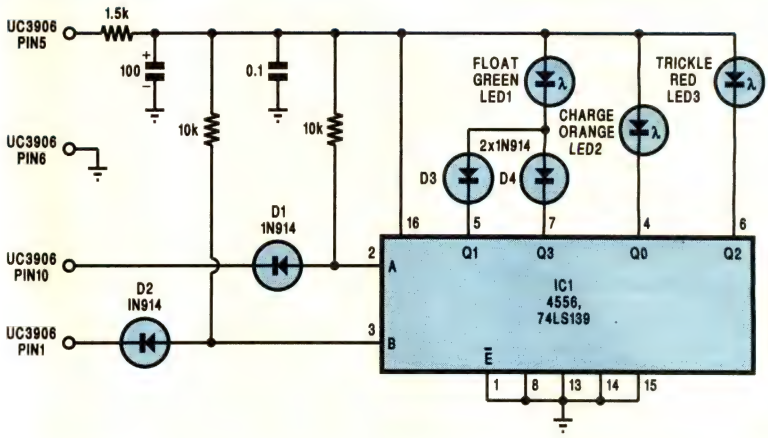
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Battery charge status monitor



This circuit gives a more reliable battery status indicator for the SLA battery charger described in the March 1990 issue of SILICON CHIP. Upon investigation, it was found that the charging mode was indicated by the logic level of the "State Level Control" output (pin 10) and the "Over Charge" output (pin 1) on the UC3906. These pins can be decoded using a 2-to-4 decoder such as a CMOS 4556 or TTL 74LS139 which then activates the appropriate LED. Pin 10 goes low when the UC3906 is in trickle or main charging mode and high for float charge. Pin 1 goes low for main charge only. See the charge graph of the UC3906 in the article on page 11 of the March 1990 issue for details.

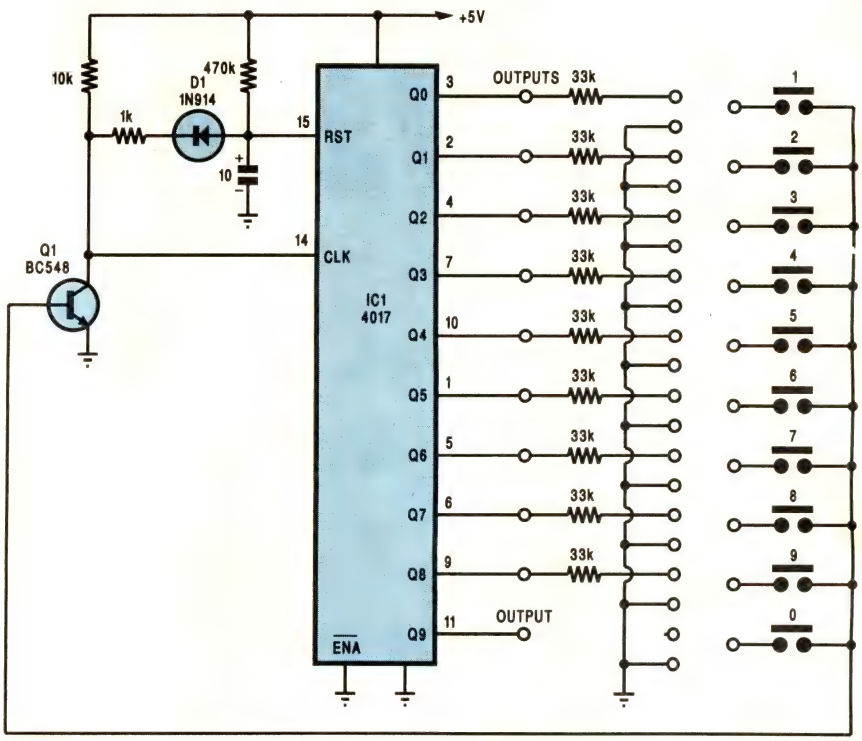
The LEDs are connected to the output pins of the decoder as shown with the "Float" LED being connected via two 1N914 diodes to keep the LED on when fully charged. The 560Ω resistor provides current limiting for the LEDs. As only one LED is on at a time, a single resistor is all that is required.

IC1 is a dual decoder and the second half is not used, so pins 13, 14 & 15 should be tied low. If a 4556 cannot be obtained, then a 74LS139 can be used with the following changes: (1) delete the two 10kΩ resistors; and (2) replacehe the 1.5kΩ supply resistor with a 78L05 voltage regulator to provide a 5V source.

The LEDs were wired to the board using their original wires but their order was changed so that Red = Trickle; Yellow = Charge; Green = Float.

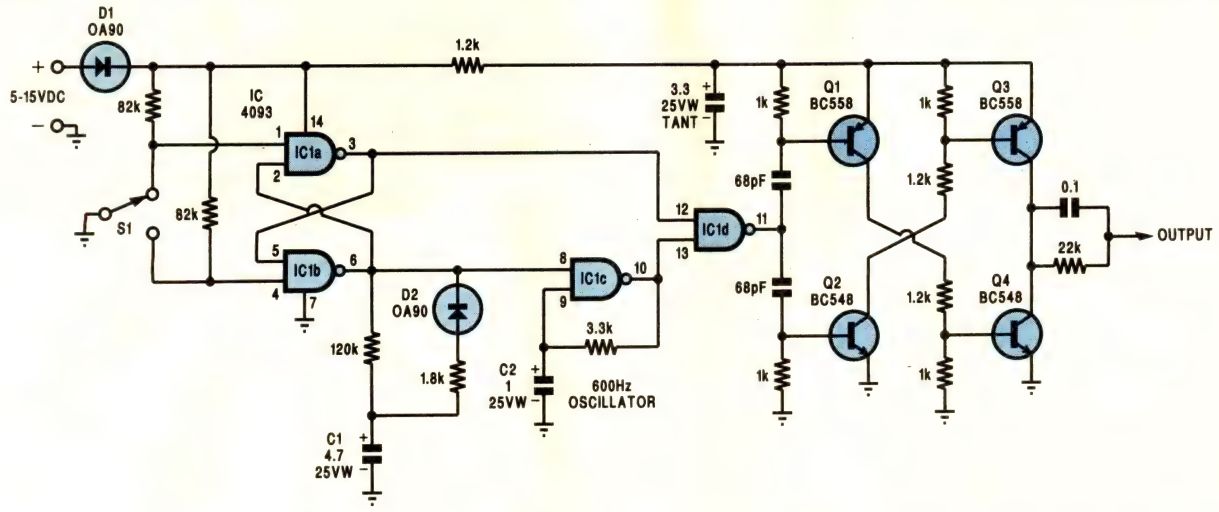
Douglas Ritson,
Ourimbah, NSW. ($20)

Single-chip combination lock



This simple lock circuit has 10^9 possible combinations. Nine buttons on the keypad are used and each button can be wired to any of nine outputs Q0 to Q8 of IC1. The tenth output, Q9, is used as the output of the circuit, to drive a relay via a transistor. Whenever a correct button is pressed, the output of transistor Q1 goes low, disabling the reset pin of IC1 and discharging the timing capacitor. When the button is released, the collector of Q1 goes high and this positive edge increments the 4017 counter, and the capacitor starts to charge. There is about a 3-second limit before the next button must be pressed, or else the charging of the timing capacitor will reset the counter.

This sequence is followed until a maximum of 9 correct buttons have been pressed. When all correct but-



Pulser probe for TTL & CMOS

This probe will generate a single pulse or a pulse stream, depending on how long pushbutton S1 is pressed. The circuit uses a 4093 quad 2-input Schmitt NAND gate package. IC1c is connected as a free-running square wave oscillator which is enabled whenever its pin 8 input is low. This happens whenever S1 is pressed long enough to allow C1 to charge and thus take pin 8 high.

If S1 is pressed only briefly, the resulting high to low transition at pin 3 of IC1a is coupled through IC1d which goes high at pin 11.

Pin 11 of IC1d is capacitively coupled to the output stage comprising transistors Q1 to Q4. If pin 11 goes high, Q2 and Q3 turn on while Q1 and Q4 are held off. This pulls the output low. Similarly, if pin 11 goes low, Q1 and Q4 are turned on and Q2 and Q3 are held off. This pulls the output high.

Greg Freeman,
Nairne, SA. ($25)

tons have been pressed in the right sequence, the Q9 output at pin 11 goes high for three seconds, as set by the 10µF capacitor and 470kΩ resistor at pin 15.

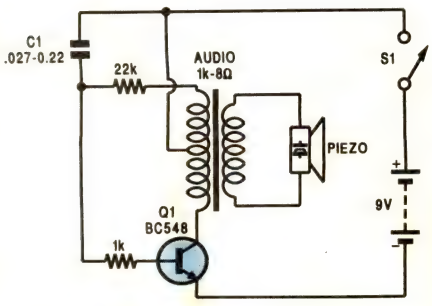
The keypad combination is hardwired by connecting the appropriate keys to their respective IC pins. The 4017 outputs are connected to the keypad in the order in which they are required to be pressed; ie, the first button to be pressed is connected to the Q0 output and so on. Any number of digits can be used for the combination, simply by taking the "unlock" pulse from a different output. It is also possible to re-use a digit, simply by making two connections to the relevant button. A few examples are shown below:

4017 connections: 3 2 4 7 10 1 5 6 9
Combination 1: 1 5 9 7 2 8 4 6 3
Output from pin 11
Combination 2: 8 3 6 7 3 5 8 2 4
Output from pin 11
Combination 3: 9 4 2 6 9 5 - gnd -
Output from pin 5
Combination 4: 3 6 7 4 - - - gnd - - -
Output from pin 10

Any unused keypad digits should be tied to ground.

Steven Merrifield,
Heidelberg, Vic. ($25)

Low-cost piezo screamer siren



This circuit is an oscillator based on a small 1kΩ:8Ω audio transformer. Transistor Q1 is connected to the high impedance side of the transformer which has its centre-tap connected to the +9V supply. Positive feedback is applied to the base of Q1 via 22kΩ and 1kΩ resistors and phase shift is a combination of the inductance of the transformer primary and capacitor C1.

The low impedance secondary of the transformer drivers a piezoelectric tweeter. With values ranging between .027µF and 0.1µF, the circuit can deliver quite a high output from the tweeter. Suitable 1kΩ:8Ω transformers can be obtained from suppliers such as Dick Smith Electronics (M-0216) or Jaycar Electronics (MM-2532).

Andrew Merrick,
Northbridge, NSW. ($15)

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Tektronix TDS 320 100MHz digital scope

In the last couple of years, digital scopes have been redefined & presented with an ease of use undreamt of even with analog scopes. The Tektronix TDS 320 continues this process, combining a simplified menu of control features with a 500 megasamples/second sampling rate and 100MHz bandwidth.

By LEO SIMPSON

The big challenge to scope manufacturers these days is how to combine the ever-increasing performance and potential complexity of features in a package that is intuitively easy to use. No longer do users want to refer to thick manuals to find out how to make a measurement – they want to do it all simply by pushing some buttons on the front panel.

Over last 18 months or so, we have reviewed a number of digital scopes and they have all had a different approach to solving the conflicting requirements of ease of use and flexibility of use.

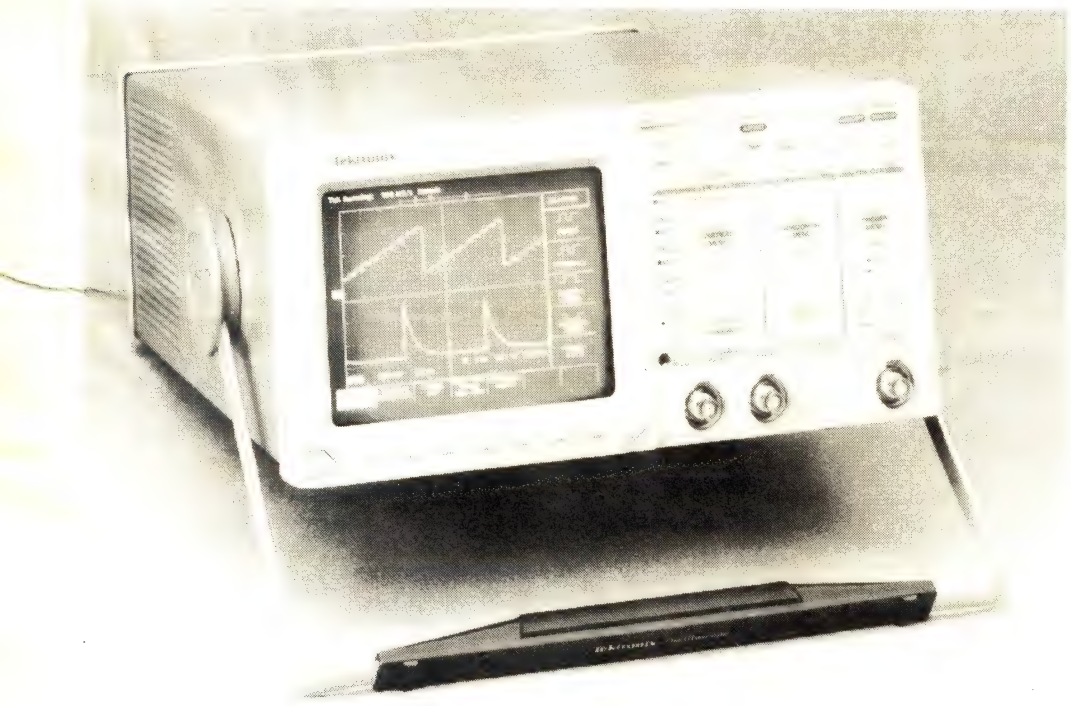
For its part, Tektronix has chosen yet another approach – one which makes extensive use of "soft" buttons and pictorial menus.

First impressions

First impressions of the Tektronix TDS 320 scope are that it is quite a bulky unit, but one which is surprisingly light for its bulk. Overall dimensions of the unit, not including its handle, are 325mm wide, 165mm high and 470mm deep, including knobs and rear projections. Its mass is only 6.8kg which means that it is easily carried with its large handle.

The front panel is uncluttered although it does carry quite a lot of buttons, when you count them all up; there are 35 buttons and six knobs. The layout is logical though and you can clearly identify the main knobs for vertical sensitivity and timebase. To the left of the vertical sensitivity knob are buttons to select channels 1 and 2 and others which become clear as soon as you press them: Math, Ref 1 and Ref 2. Math gives you the choice of CH1 + CH2, CH1 - CH2 and CH2 - CH1, all selectable via "soft" buttons down the side of the screen.

I should explain that many



The Tektronix TDS 320 is a 2-channel digital scope with main & delayed timebases, 500 megasample/second sampling rate & 100MHz bandwidth.

digital scopes nowadays make use of these "soft" buttons whereby the functions change depending on what control menu is being displayed on the screen. It actually sounds more complicated than it is to use and it is a highly practical way of providing lots of features without having huge numbers of buttons.

Naturally, there is an "Autoset" button which allows you to sit back while the scope rapidly makes all the appropriate internal adjustments to give an appropriate display of signals on the screen. It is the lazy way of doing things but it makes a lot of sense and you can then manipulate the sensitivity and timebase controls to show the waveform exactly as you want it.

One very attractive feature of a digital scope such as this is a continuously variable vertical sensitivity which is calibrated. To bring this feature into use on the TDS 320, you first press the "Vertical Menu" button and then press the "Finescale" soft button at the bottom of the screen. Pressing any of the menu buttons at the bottom of the screen brings another menu into play, down the righthand side of the screen, and these menu choices are activated by pressing the appropriate soft button at the side of the screen.

However, when the "Fine Scale" option is pressed, the topmost knob (the General Purpose knob) on the front panel is activated, and it is signified by a knob symbol in the top righthand corner of the screen. As you vary the knob, the actual gain setting is shown at four places on the screen which really is a bit of overkill. Of course, once you select some other menu option, say from the "Horizontal Menu", the vertical gain setting is shown only once, next to the appropriate channel indicator on the screen.

Hence, along the bottom of the screen you may have readings such as "Ch1 1.66V Ch2 50mV M2.5µs Ch1 ~ 33.2mV". These indicate that the vertical sensitivity for Channel 1 is 1.66 volts/div, for channel 2 it is 50mV/div, the main timebase setting is 2.5µs/div, the trigger source is Channel 1 and with triggering on positive slopes and for signals above 33.2mV. As with other digital scopes with CRT readouts, this obviates the need for any scales on the controls themselves since all the relevant settings are shown on the screen.

Coming back to the Vertical Menu, the sensitivity can be varied by the "Volts/Div" knob from 2mV/div to 10V/div if you are using a x1 probe and from 20mV/div to 100V/div if you are using a Tektronix x10 probe. The TDS 320 will recognise whether you are using Tektronix probes which have a third contact inside the socket locking ring but it will default to the gain setting for a x1 probe.

There is no probe menu to allow you to tell the TDS 320 the settings of a non-Tektronix switchable probe so you have to resort to mental arithmetic in that case.

When using the "Volts/Div" knob the gain is varied in a 1/2/5 sequence while in the Fine Scale mode the gain is continuously varied with 3-digit resolution, in steps ranging between 0.4% and 1%. For example, if the gain is in the range from 100mV/div to 200mV/div it is varied in 1mV steps, while in the range from 200mV/div to 500mV/div it varies in 2mV steps. This is in line with the 8-bit vertical resolution of the instrument. Vertical gain accuracy is ±2%.

Timebase

The main and delayed timebases are not able to be varied continuously but they are adjusted in four steps per decade; ie, a sequence of 1/2.5/5 which is adequate for just about all foreseeable measurement situations. When you want to make precise measurements on waveforms you don't need to vary the timebase; you either use the vertical cursors or just call up one of the many measurement options which we'll come to later. The timebase accuracy is ±0.01%.

Pressing the "Horizontal Menu" button brings up two options at the bottom of the screen and a number of options down the righthand side: Main Only, Intensified, Delayed Only and then a fourth message such as "Delayed Runs 4.13722ms After Main". Whichever option you pick from the side menu is then echoed at the bottom of the screen together with another option for Trigger Position. Pressing this soft button gives you three options for trigger position: 10%, 50% and 90%.

This concept may seem a little odd until you realise that with a digital scope you can display part of the waveform before the nominal trigger point. In fact, the entire record of a trace has 1000 sample points and only the middle section of this record is normally displayed. You can scroll along this record by using the horizontal position control. Hence, the 50% trigger option is in the centre of the trace and is indicated by a "T" symbol (although again, there is an option to turn that off).

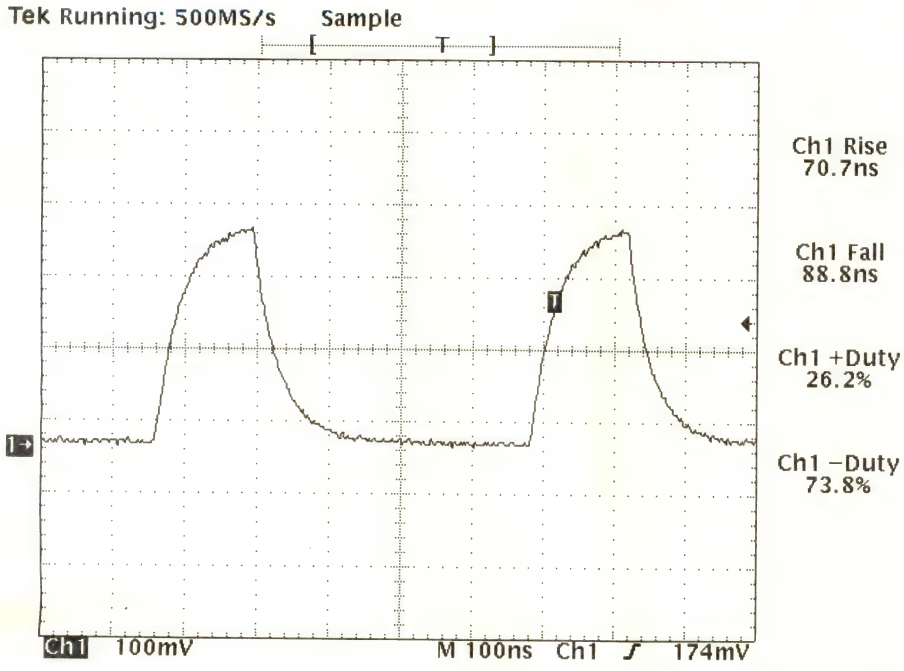
The high rate of sampling means that it is tops at catching glitches which are undetectable on other scopes. It can detect glitches a short as 10 nanoseconds at all timebase settings between 25µs/div and 2.5 seconds/div.

Triggering

There is also a Trigger Menu button and pressing this gives two broad options of either edge triggering (positive or negative slope) or video triggering via the in-built sync separator. This latter option enables the scope to be triggered on field 1 or field 2 or the lines of a composite video signal such as PAL or NTSC. (Note that the instrument does not have a line selector).

Measurements

There are 21 automatic measurements available with the TDS 320 and they are brought into play by pressing the "Measure" button. This brings up five options along the bottom of the screen and pressing any of the accompanying soft buttons brings up options down the side of the screen. For example, pressing "Select Measurement" brings up the first four of the 21 measurements and these can be paged through to pick the ones you want. Each measurement option is accompanied by a little diagram which



A typical screen display from the TDS 320. In this case, one channel is shown together with measurements of pulse rise time, fall time, & positive & negative duty cycles. Note that the menu at the side of the screen has been cleared so that the measurements can be displayed without obscuring the waveform.

shows just what is being measured.

This "pictorial approach" is used extensively on the TDS 320 and is very useful even for those who are very familiar with scope measurements. Seeing the little diagrams makes the measurement selection quite unambiguous and would be a boon for anyone not so familiar with the English language or for students leaning about scopes.

The instrument also provides a running commentary about the measurements. For example, it might accompany a measurement of rise time with a "low resolution" comment. This means that you should select a faster timebase speed. All 21 measurements will be accompanied by comments where applicable and again, this can be most helpful, even to experienced users.

One problem that can arise with on-screen measurements is that they are superimposed over the waveforms and this can lead to a lot of clutter. Tektronix has thought of that too. If you push the "Clear Menu" button, all the measurement readings are transferred to the area down the side of the screen. Result: no clutter.

One aspect which could be argued about relates to the selection and removal of measurements from the screen. As presented, you can select up to four of the 21 possible measurements on the screen. If you want to select an additional measurement, the TDS 320 flashes up a message which states that only four are allowed. You then have to clear that message, push the "Measure" button again to bring up the measure menu and then push "Remove Measurement". You then have the option of removing any or all of the existing four measurements after which you can select another measurement.

On other brands of digital scopes, the measurements are displayed on the screen in a FIFO (first in, first out) scheme; ie, the first measurement in is the first to disappear off screen as you select more measurements. That has the beauty of simplicity but it can mean quite a few button presses to display the particular set of measurements you want.

Cursors

As well as the automatic measurements noted above, you can also perform volts and time related measurements using moveable vertical and horizontal cursors. You can then measure absolute volts, delta volts, frequency and time difference.

Performance

All of the foregoing has focused on the user features of the TDS 320 without really mentioning its overall performance. It really does have quite remarkable performance with 500 megasample/second sampling rate, giving a true 100MHz bandwidth even for "single shot" mode. And the high rate of sampling means that it is tops at catching glitches which are undetectable on other scopes. It can detect glitches a short as 10 nanoseconds at all timebase settings between 25µs/div and 2.5 seconds/div.

That's pretty amazing stuff and is indicative of a level of performance that was unthinkable in instruments in this price range before the TDS 320 was released just a couple of months ago.

Excellent manuals are provided with the TDS 320 although most users should seldom need to refer to them. There is a large spiral bound instruction manual, a 4-page reference manual showing the menu maps and controls, a 72-page spiral bound manual entitled "Basic Concepts" which would be an excellent source for anyone learning about scopes and finally, a 3-ring binder programming manual which allows you to fully exploit the GPIB and parallel printer interfaces of the TDS 320 if you purchase that option.

Perhaps I should make some comments about the optional GPIB and printer interfaces. As with most other scope manufacturers, Tektronix makes the TDS 320 available without any interfaces but to my mind, buying an instrument such as this without the interfaces means that you are not getting the full benefit of the product. We had only a few days with the review instrument and it did not have any interfaces on it as it was an advance sample.

Another option which could be very useful is a thermal printer mounted in a pouch on top of the scope.

Points for improvement

Any complex product such as this always has facets which could be improved and, in fact, Tektronix has a

policy of continuous upgrades. With this in mind, there are some points which could be improved. Perhaps the most noticeable is the fan which is quite noisy. I mentioned this to the Tektronix sales staff and they assured me that this aspect would definitely be improved.

So much for the hardware. All the other *points of* note relate to the software and could probably be easily modified. For example, when you select the "Fine Scale" option for vertical sensitivity, it would be more logical if the gain was then continuously varied by the Volts/Div knob than by the general purpose knob at the top of the control panel. A probe menu would be useful too, so that non-Tektronix probes can be used. This could be a subset of the "Coupling" menu.

Finally, when you have selected an option which involves the general purpose knob, a knob symbol appears in the top righthand corner of the screen, as already noted. However, as soon as you touch the knob, the symbol disappears even though you can still use the knob while ever the same menu is displayed on screen. In this reviewer's opinion, the knob symbol should remain on screen while ever the facility is available.

Tektronix has a policy of continuously upgrading the internal software of their scopes so maybe some or all of these quibbles will be addressed in the near future.

Conclusion

To conclude, the Tektronix TDS 320 is high-performance scope which is deceptively easy to use. In some ways, its ease of use conceals the power of the instrument. This is a paradox that comes about because in the past high performance instruments of any type have generally not been easy to use. We should also emphasise that space limitations and the brief time we had the sample scope meant that we have not been able to cover the full range of features.

The price of the Tektronix TDS 320 is $4395 plus sales tax, while Option 14 (the GPIB and Centronics printer interface) is $774 plus tax.

For further information on the TDS 320 and other digital scopes in the range, contact Tektronix Australia Pty Ltd, 80 Waterloo Road, North Ryde, NSW 2113. Phone (02) 888 7066. **SC**

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Lesson 1

Programming the Motorola 68HC705C8 microcontroller

Following our series on the MAL-4 Microcontroller Aid for Learning, we now present a series of lessons on programming its central device: the MC68HC705C8 microcontroller. If you've always wanted to learn about microcontrollers, this series will give you a good grounding.

By BARRY ROZEMA

Welcome to the fascinating world of microprocessors and microcontrollers. Over the next few months, we will be showing you how to program the Motorola MC68HC705C8 single chip microcontroller. This microcontroller unit (MCU) is a member of the large 6805 family and the lessons will be based on its internal architecture and instructions set. We will be using the MAL-4 Microcontroller Aid for Learning for the practical parts of the lessons (see SILICON CHIP – Nov-Dec. 1992 & Feb. 1993).

The lessons are aimed at everyone from keen beginners to those with some programming experience but who need to refresh their knowledge of microcontrollers. However, to get the most from the lessons, you should at least have a reasonable grounding in digital electronics.

Each lesson will consist of:

- Theory.
- Practical program examples.
- Things to do between lessons.
- A new program to try.

Note, however, that the lessons will be specific to the MC68HC705C8 microcontroller and its associated hardware. It will also be necessary for you to do some further reading after completing each lesson.

As you are probably aware, when it comes to electronics, you can never have too many text and reference books. The microcontroller area is no exception.

There have been many good text books written about microprocessors, most of which have been written for specific devices. Unfortunately, I have not seen any based on the 6805 family to date. However, any microprocessor text written around an 8-bit Motorola processor or 6502 processor may suffice; eg, Microprocessors & Microcomputers, The 6800 Family or The 6502 Family, by Ronald J. Tocci & Lester P. Laskowski (Prentice-Hall).

A good digital text book will also be of value; eg, Digital Systems, Principles & Applications, by Ronald J. Tocci (Prentice-Hall).

You will also need the MAL-4 Operation and Construction Manual, plus two publications from Motorola:
(1) Microprocessor, Microcontroller & Peripheral Data, Volumes 1 & 2.
(2) MC68HC705C8 8-Bit Microcontroller Unit. Technical Summary. BR-594/D Motorola.

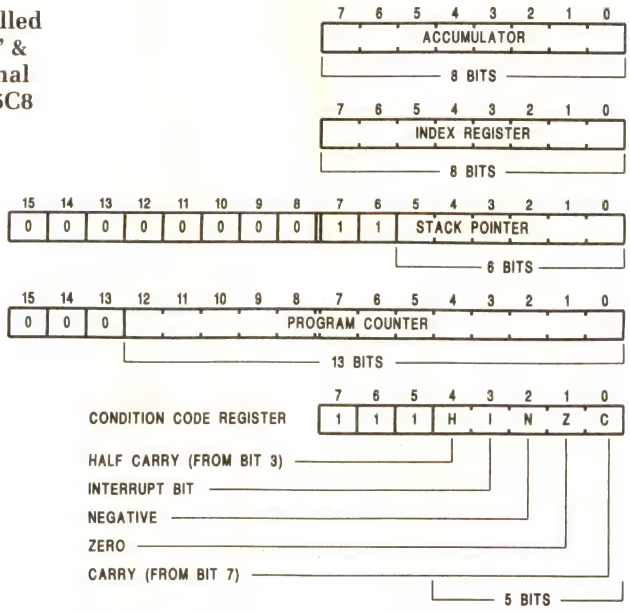
7 6 5 4 3 2 1 0
ACCUMULATOR
8 BITS
7 6 5 4 3 2 1 0
INDEX REGISTER
8 BITS
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0 0 0 0 0 0 1 1
STACK POINTER
6 BITS
15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 0 0
PROGRAM COUNTER
13 BITS
7 6 5 4 3 2 1 0
CONDITION CODE REGISTER
1 1 1 H I N Z C
HALF CARRY (FROM BIT 3)
INTERRUPT BIT
NEGATIVE
ZERO
CARRY (FROM BIT 7)
5 BITS

Fig.1: this diagram is called a "programming model" & shows the various internal registers of the 68HC705C8 microcontroller.

Hardware

To carry out the practical aspects of the course, you will require a MAL-4 Microcontroller Aid for Learning with a power supply and loudspeaker. You should be well read with regard to the MAL-4 operations manual and you should be able to load programs and run them.

Programming concepts

All microprocessors and microcontrollers, from those used in main-

frames to the simplest MCUs, must be capable of running a "program". A program is simply a list of instructions that are to be carried out (executed) in a given order. All microcontrollers run in "machine code", although this is usually hidden from us by what are called "higher level languages". Some typical higher level languages include Pascal, Forth, Basic, DOS and Windows. Even the humble word processor can be regarded as a higher level language.

The level of instructions in a given application depends on the power of the processor. For example, an adult human can easily understand and carry out an instruction "go to the shop and get some milk please". No other information would be necessary. But if you wanted a child to perform the same task, you would have to give the correct change for the milk, instruct him on how to cross the road safely, and provide other information that would not be necessary with an adult.

Now try to give the same task to a robot. You would have to give every detail of the job. For example, you would have to tell the robot how and when to lift its legs, how to maintain its balance and how to get out of the door – and that's before you even tell it how to successfully find its way to the shop. In fact, the task is probably impossible given today's level of robot development.

Machine code

All microcontrollers are similar in the way they are programmed. You cannot say "go and get the milk please". Instead, you have to lay out each step in machine code form.

Machine code – also called op-code (for operation code) – is issued in binary form and is simply an instruction code for a given machine or microprocessor. In the case of the 8-bit MC68HC705C8 microcontroller, it takes the form of an 8-bit binary code. To make it easy for us, this binary code is hidden in the form of other numbering formats, such as octal, hexadecimal or decimal.

In most cases, the hexadecimal format is used for programming and this also applies to the MAL-4. But what ever the programming format used, the processor still works in binary. Hexadecimal numbers in these lessons will have a "$" sign in front of them; eg, $1234, $EA, $1FFE.

If we wanted a program larger than say 10 bytes, it would be very difficult to write in either binary or hexadecimal format. That's because we are not very good at remembering numbers and because we find it hard to relate hexadecimal numbers to events. Although the microprocessor understands binary instructions, we need to program in "plain" language.

For example, to load an accumulator we could use the instruction "Load Accumulator", or other instructions

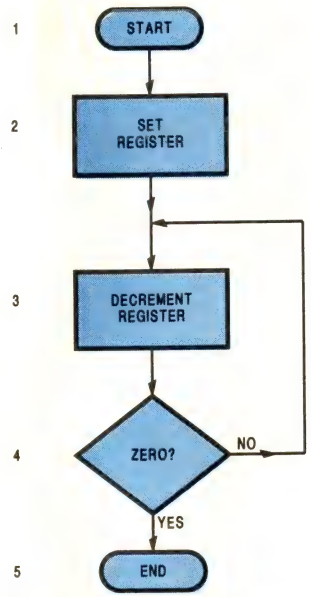

Fig.2: this flowchart shows an MCU counting down to zero. Symbols 1 & 5 are terminators, symbols 2 & 3 are process blocks, & symbol 4 is a decision block.

like "Store Accumulator" and "Or Accumulator". This is how the instructions are written for the human side of the program, though in a shortened form called "mnemonics" (pronounced nu-mon-ics). The last three instructions in mnemonic form would look like this:

LoaD Accumulator - LDA
STore Accumulator - STA
OR Accumulator - ORA

To write a program using mnemonics, the programmer first thinks of the instruction in plain language. He then finds the correct mnemonic and looks up the applicable binary machine code (usually given in hexadecimal). The MC68HC705C8 has 62 of these mnemonic instructions – see p.28 of the MC68HC705C8 Technical Summary.

A typical microprocessor program consists of a series of mnemonic instructions which are then converted into hexadecimal op-code. This code is stored in the memory and the MCU then "runs" the program.

Programming model

In order to program the MC68HC705C8, we need to find out what internal registers are available. Fig.1 shows the details for this device. This diagram is called the "programming model" (all microprocessors have one) and it enables the programmer to best utilise the CPU. A brief explanation of the registers in the MC68HC705C8 follows.

Accumulator

The accumulator is the workhorse of the CPU. Some microprocessors have more than one accumulator but the 6805 only has one. A better name for the accumulator would be "general purpose, do-almost-everything register".

Like the MCU, the accumulator is eight bits wide. Its contents can be loaded from memory or stored in memory. We can add, subtract and multiply with it; perform logical functions (AND, OR, NOT & XOR) with it; shift it right or left; rotate it right or left; increment or decrement it; and negate it (2s complement).

To understand how the accumulator is used, picture yourself at the kitchen sink washing dishes. With one hand you grab a dirty plate and place it in the sink. You wash it. With your other hand, you then take the clean plate out of the sink and place it on the dish rack to dry.

This process is analogous to the way in which we use the accumulator – for example, to take data from the input port and place it on the output port. To do this, we must first LOAD the accumulator from the input port, then STORE the accumulator at the output port.

Going back to our analogy, when washing up, we can not send the dirty plate directly to the dish rack – we must handle it and wash it up. A similar situation applies to data – it must be "handled" by the accumulator. The 6805 family has no instruction to direct data around the memory; eg, from output to input.

Index register

The index register operates in a similar manner to the accumulator.

Table 1: Noise 1 Laser/Spaceship Sound Generator Program

Address	Data	Label	Mnemonic		Comments
0030	A6 00	Start	LDA	#$00	;Set highest frequency
0032	B7 BF		STAZ	TEMP	;Store at temporary memory
0034	B6 BF	Loop 1	LDAZ	TEMP	;Get delay time
0036	CD 14 A1		JSR	D100US	;100us X ACC delay
0039	B6 02		LDAZ	PORTC	;Get speaker
003B	A8 80		EOR	#$80	;Complement speaker
003D	B7 02		STAZ	PORTC	;Store speaker
003F	3C BF		INCZ	TEMP	;Inc delay time
0041	B6 BF		LDAZ	TEMP	;Get delay time
0043	B1 00		CMPZ	PORTA	;Compare with Port A
0045	27 E9		BEQ	START	;Start again if equal
0047	20 EB		BRA	LOOP1	;Back to loop1

Comment: this program causes the MAL-4 to generate a laser/spaceship sound from its loudspeaker. The program is loaded from RAM location $0030. The DIP switch on PORT A changes the sound. Be sure to enable PORT A by turning DIP SW2 7 (E) on. Try changing location $0031 from $00 to other values.

Like the accumulator, it is an 8-bit register but it can not do all the arithmetic and logic operations that the accumulator can do. However, the index register can perform a very powerful form of programming called indexed addressing, whereby it is used to point to individual memory locations.

Stack pointer

This 6-bit register is used by the CPU itself. The stack pointer points to a RAM location where the CPU can store or load data. The stack pointer moves down to store new data or moves up to load old data. In this respect, it functions like a FILO (First In Last Out) register. The stack pointer memory range is $00FF-$00C0.

Program counter

The program counter is a 13-bit register that keeps track of a program's location in memory. When we start a program from a given memory location, the program counter must be loaded with the start location. As the program progresses through memory, the program counter keeps track of the location. If the program has to jump or branch to another memory location, this is achieved by changing the program counter. The 13 bits of the register give an addressing range of 8Kb ($0000-$1FFF).

Condition code register

The condition code register (sometimes called the flag register) is a 5-bit register. This register tells us what happened in the ALU (arithmetic logic unit) on the previous instruction(s). If we use conditional branching, the CPU looks at the flags in this register to decide if it should branch. A detailed look at each instruction will show how and which flag is affected.

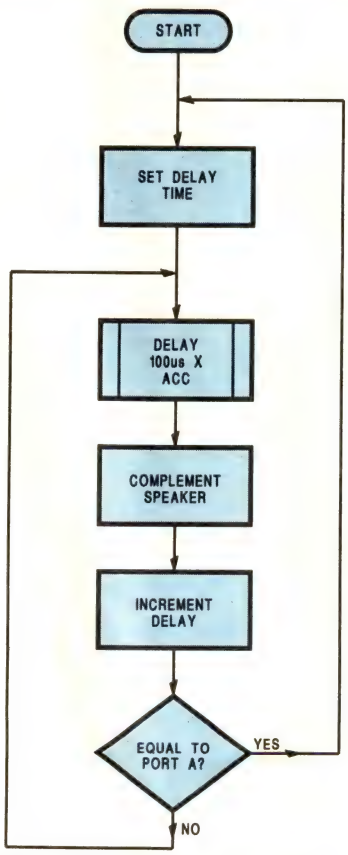

Fig.3: this is the flowchart for the laser/spaceship sound program listed in Table 1.

Flowcharts

The old saying "a picture is worth a thousand words" is very true, especially when we are programming MCUs. The "picture" that programmers use is called a flow chart. A flow chart consists of symbols "strung" together, usually stacked vertically from top to bottom. Each symbol indicates a particular function, either carrying out an instruction or making a decision.

For example, the flowchart in Fig.2 shows an MCU counting down to zero. This could be used to give a time delay. Symbols 1 and 5 are terminators – they indicate the start and finish of a program (or part of a program). Symbols 2 and 3 are process blocks and indicate a process or operation.

Symbol 4 is a decision symbol. It has one input and two outputs. One output is for a result that is true, while the other is for a result that is untrue. The result from a decision is binary; ie, true/false, yes/no or zero/one.

The best way to study a flow chart is to follow it with your finger in the direction of the arrows until you come out at the end. Although there are many flow chart symbols, we will only use five basic types during this course.

Subjects to study

Following is a list of things to study before next month's lesson, listed in order of importance:

(1.) Microprocessor fundamentals: basic operation; block diagrams; central processing unit (CPU)

(2.) Numbering systems: binary to hexadecimal to decimal

(3.) Motorola MC68HC705C8 8-Bit MCU Technical Summary; pages 1-11, 28-31.

Sample program

Finally, Table 1 list a simple program that generates laser/spaceship sounds using the MAL-4. Try entering the program as set out in the instruction manual and be sure to enable PORT A by turning DIP SW2 7 (E) on.

The program is loaded from RAM location $0030 and the DIP switch on PORT A changes the sound. SC

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IC Data

THE ISD1016 VOICE RECORDER IC

Using new techniques, Information Storage Devices in the US has designed a 16-second voice recorder on a single chip. It stores an analog signal directly in an internal EEPROM, making battery back-up redundant.

By DARREN YATES

During the last few years, quite a lot has happened to the way we record and store sound. In addition to the new hifi digital tape formats, digital recorder ICs have also slowly begun to take off as their advantages in certain applications are recognised.

The obvious advantage is that digital recorder ICs have no moving parts. The motors, gears, heads and tape of the conventional machines are replaced with clock oscillators, A/D converters and dynamic RAM (DRAM). Result – greater reliability and much reduced power consumption.

However, at this stage, solid state recorders cannot compete with tape machines (either analog or digital) in terms of sound quality or recording length. For example, it would require one 256K x 8 DRAM chip for every second of CD quality stereo sound.

That said, the solid state devices have real benefits in applications where you only need voice quality recordings.

Digital storage

The digital storage technique uses A/D converters to sample the audio waveform and the resulting binary numbers, representing the sampled values, are then stored away in DRAMs. Similar A/D converter techniques are used in CDs and digital audio tape recorders, except of course the storage medium differs.

When the audio is to be recovered, the binary numbers are fed into a digital-to-analog converter (DAC) and the output filtered to recover the original waveform. But although dynamic RAMs are cheap, fast and easily available, they do have a few bugbears.

First, they are power hungry so you can forget about long battery life in portable devices. Second, the memory is volatile – if the power is removed, the recording is lost.

The EEPROM advantage

That's where we come to the ISD1016A Single Chip Voice Record/Playback device from Information Storage Devices. Released in early 1992, this IC differs from other solid-state devices in that it stores the sampled waveform in analog form. And instead of storing the data in volatile dynamic RAM, it stores it in a non-volatile EEPROM (Electrically Erasable Programmable Read-Only Memory) that's built right into the chip.

The main advantages of this technique are better sound quality and the fact that the recording is retained in memory even when the power is turned off. And because the information is stored in the EEPROM in analog form, there's no need for A/D and D/A converters.

Actually, the ISD1016A is just one of three voice recorder chips from Information Storage Devices. The other two devices are the ISD1012A and the ISD1020A and these have recording/playback durations of 12 seconds and 20 seconds respectively.

Block diagram

Let's take a closer look at how the ISD1016A IC works – see Fig.1. This device combines both digital and analog electronics on the one chip, as well as a 128,000-cell EEPROM array – enough for 16 seconds of telephone-quality audio. It comes in a 28-pin DIL or PLCC package and runs off a 5V rail.

Starting at the input, audio can be fed in from either a dynamic or electret microphone to a preamplifier stage, or it can come from a line level output; eg, from a CD player or tape deck. The gain of the microphone preamplifier is controlled by an automat-

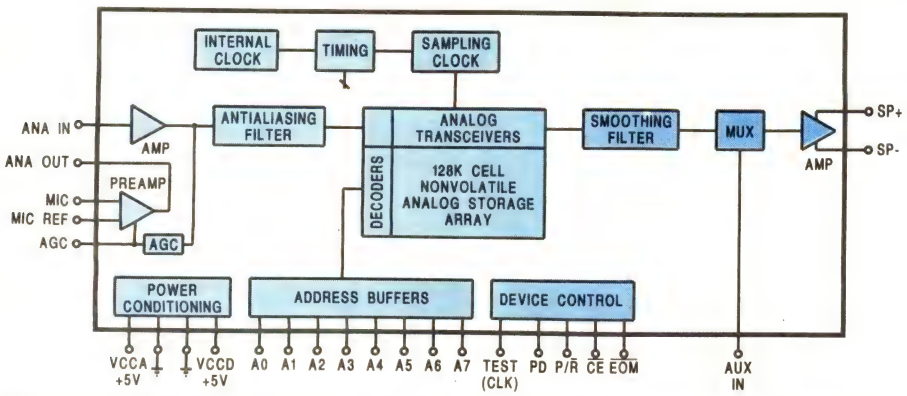


Fig.1: block diagram of the ISD1000A chip family. The devices store the audio signal in an internal EEPROM that retains memory when the power is switched off. Other features include cascading & multiple message address options.

ic gain control (AGC) circuit. This makes recording an easy task, as there are no recording levels to set.

The preamplifier output is coupled into the main input amplifier (via the ANA OUT & ANA IN terminals) and this in turn drives an anti-aliasing filter. This filter is a hefty 5th order Chebychev design which cuts all frequencies above approximately 40% of the sampling frequency. This is done to eliminate any mixing effects between the input frequency and the sampling frequency.

In this IC, the sampling rate is 8kHz and the audio frequency cutoff point is 3.4kHz. Following the filter, the audio signal is sampled and stored in the 128K cell EEPROM. This is where the new technology is involved.

Because analog techniques are used, the information storage density is eight times that of a conventional digital system. This eliminates the need to use data compression or fancy algorithms to get the physical size down.

What happens is that each cell forms part of a closed loop which includes a comparator. A sample-and-hold circuit applies the analog voltage to be stored to one input of the comparator. The other input is connected to the cell itself. The cell is then "pumped up" using programming pulses until its voltage is the same as the analog voltage from the sample-and-hold circuit. When the two voltages are equal, the comparator shuts down the programming pulses.

The magnitude of these programming pulses sets the resolution and hence the clarity of the recording. In the ISD1016A, there are approximately 256 levels and this translates into 8-bit resolution.

In operation, it takes a fair amount of time to store a sample in the EEPROM array – about 10 milliseconds, in fact. And since we are taking a sample every 125 microseconds, we must either lose some information or find some way of temporarily storing it.

To overcome this problem, the ISD1016A has two rows of 80 sample and hold circuits. One row records the input in real time in serial mode, while the other row is connected in parallel to program multiple cells in the EEPROM simultaneously. By using this arrangement, the IC can sample every 125µs and still take 10ms to program the multiple EEPROM cells without losing data.

TABLE 1: PIN FUNCTIONS

Pin	Pin No.	Function
A0-A5	1-6	Address
A6-A7	9, 10	Address
VCCD	28	Vcc Digital Power Supply
VCCA	16	Vcc Analog Power Supply
VSSD	12	VSS Digital Ground
VSSA	13	VSS Analog Ground
SP+	14	Speaker Output +
SP-	15	Speaker Output -
Test (CLK)	26	Test - Must Be Tied Low
Aux In	11	Auxiliary Input
Ana Out	21	Analog Output
Ana In	20	Analog Input
AGC	19	Automatic Gain Control
Mic	17	Microphone Input
Mic Ref	18	Microphone Reference
PD	24	Power Down
P/R-bar	27	Playback/Record
EOM-bar	25	End-of-Message
CE-bar	23	Chip Enable

An internal clock provides the timing signals for the sample and hold circuits. This clock is accurate to ±2% over the specified temperature and voltage range to ensure good speech fidelity. If greater accuracy is required, the chip can be externally clocked via its test (CLK) pin.

Playback

During playback, the signal is clocked out of the EEPROM array and passed through a smoothing filter. This filter removes the sampling frequency content of the signal and drives a multiplexer stage, which selects either the output from the EEPROM array or signal fed in from an auxiliary input. From there, the signal is fed to an audio amplifier which can provide 50mW into a 16-ohm load. An 8-ohm loudspeaker can also be used, provided a 10Ω resistor is installed in series with one of the output leads.

Multiple message options

One useful feature of the chip is its ability to play back one of many individual message stored in the EEPROM, or to repeat a message continuously or at set intervals.

The 128,000 cells in the EEPROM are arranged into 160 rows of 800, each row corresponding to 0.1s of storage. Each row can be individually addressed as a starting point, allowing the device to broken up into 160 separate "phrases".

The starting address of a recording is set by applying an 8-bit code to external address pins A0-A7. When the recording is stopped, an End-Of-Message (EOM) marker is inserted to mark the end of the message. Playback can then be initiated from the relevant addressed location and continues until the EOM marker is encountered.

In practice, this means that several short messages (or even single words) could be stored in the chip and accessed at will. The device could therefore be used to play back single word instructions in response to user inputs, or even to construct entire phrases under software control.

For example, the device could be used to provide voice annotation in test equipment, microwave ovens, vending machines and toys, to name just a few applications.

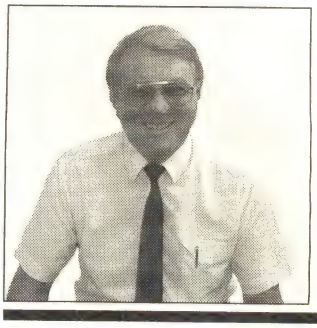
Longer recordings

One problem with DRAM designs is that the main sound chip can only address so much RAM – usually 1MB at most – and this severely limits the maximum recording time. However, unlike its digital counterparts, the ISD10XX series overcomes this problem by providing a simple cascading facility to obtain longer recording times. Cascading four ISD1016 devices, for example, will give up to 64 seconds of speech, while 10 devices will provide a recording time of 2 minutes 40 seconds.

Finally, the ISD1016 also has a number of control inputs which can be programmed using external switches or logic circuitry (eg, a microcontroller). These include chip enable (CE-bar), playback/record (P/R-bar) and power down (PD). Pulling the PD pin high when the unit is not recording or playing back switches the unit into a low-power standby mode to reduce the operating current from 25mA @ 5VDC to less than 1µA.

Further information on the ISD-1016A voice recorder IC is available from R & D Electronics, PO Box 179, Springvale, 3171. Phone (03) 558 0444 or (02) 712 3855. **SC**

ALTRONIC COMPONENTS



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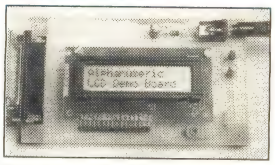
Alphanumeric LCD Module Kit



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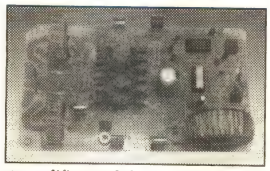

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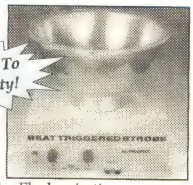

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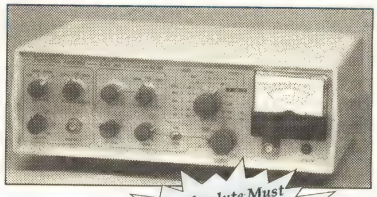

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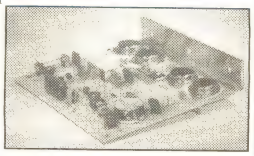

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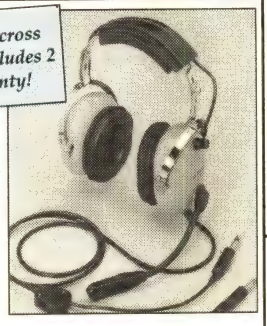

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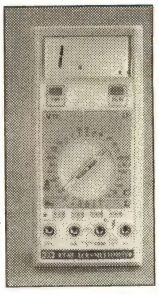

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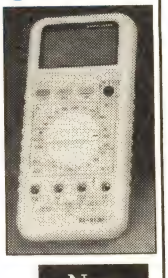

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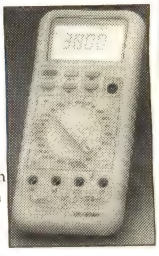

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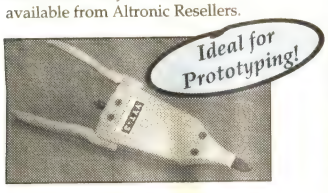

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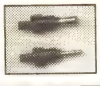

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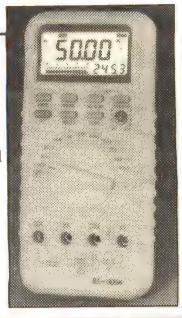

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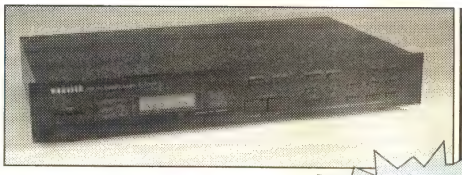

This fantastic tuner is the ideal add-on to any sound system. Can be used for background music in restaurants, shops etc. or for any P.A. application. Also a great upgrade for the home Hi-Fi.

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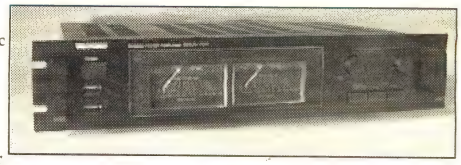

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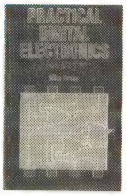

By Mike Tooley. For those people interested in moving into the World of Digital Electronics, this book is an excellent introduction. It offers nine digital test projects to build which can be constructed on veroboard. As well as containing a range of CMOS and TTL data including some pinouts. Suitable for enthusiasts and students alike.

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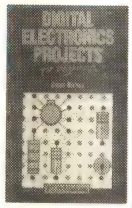

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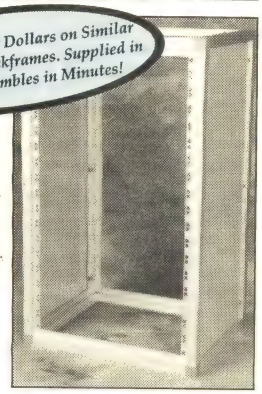

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H 5307	Panel set for H 5306	$55.00
H 5312	Rack frame 12U Black	$169.00
H 5313	Panel set for H 5312	$89.00
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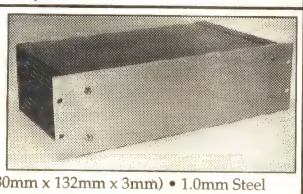

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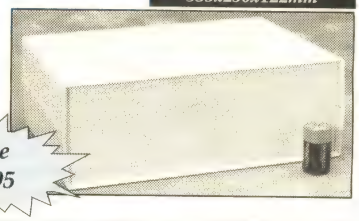

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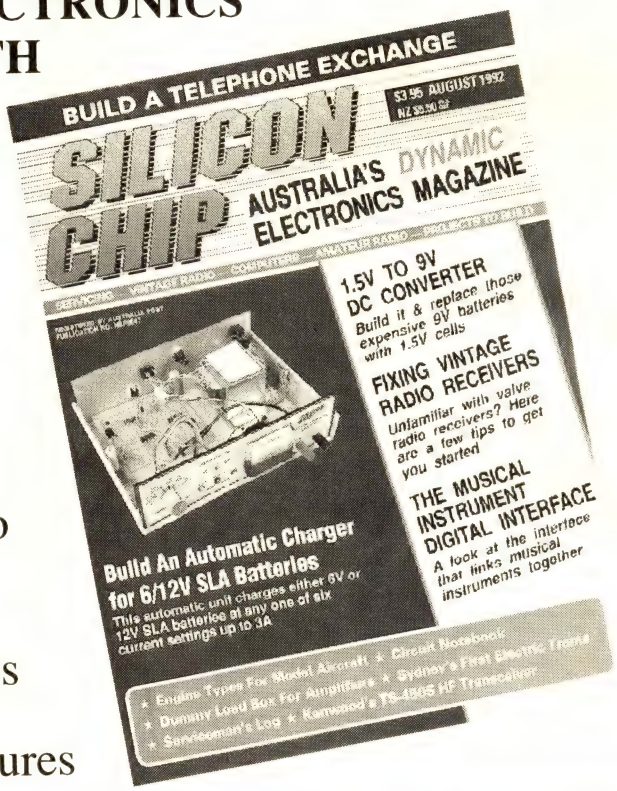
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Build this single chip MESSAGE RECORDER

By DARREN YATES

Throw away those old messages on the fridge. This project records up to 16 seconds of audio using a new sound chip that retains the recording even when the power is turned off.

It happens in just about every household every day. One family member has to rush out and go somewhere but needs to leave a message for someone else in the family to take the chops out of the fridge or bring the clothes in, etc.

The tried and true technique is the paper message stuck to the fridge using a rubberised magnet – if you can find paper and pen, that is. How much time has been wasted searching for those two items in your household? And even if you do have a message pad, it's always completely used up when it's your turn to write something.

If that's a common scenario in your house, then this solid-state Message Recorder is just what the doctor ordered. It can record up to 16 seconds of speech (or music) and, unlike earlier designs, is based on a single chip that doesn't require a back-up battery or external memory devices or controllers.

The project fits inside a small plastic case and is operated using just two pushbutton controls. To record a message, you simply hold down the RECORD button and speak into the microphone. The message can then be replayed at any time by holding down the PLAYBACK button.

Unlike a tape recorder, you don't have to worry about "rewinding" the unit at the end of the message. That's because the message is stored in memory inside the IC. Each time you press the PLAYBACK button, the message automatically starts from the beginning.

When you want to record a new message, you simply record over the top of the old one – just as you would with an ordinary cassette tape. This eliminates the need for an erase control.

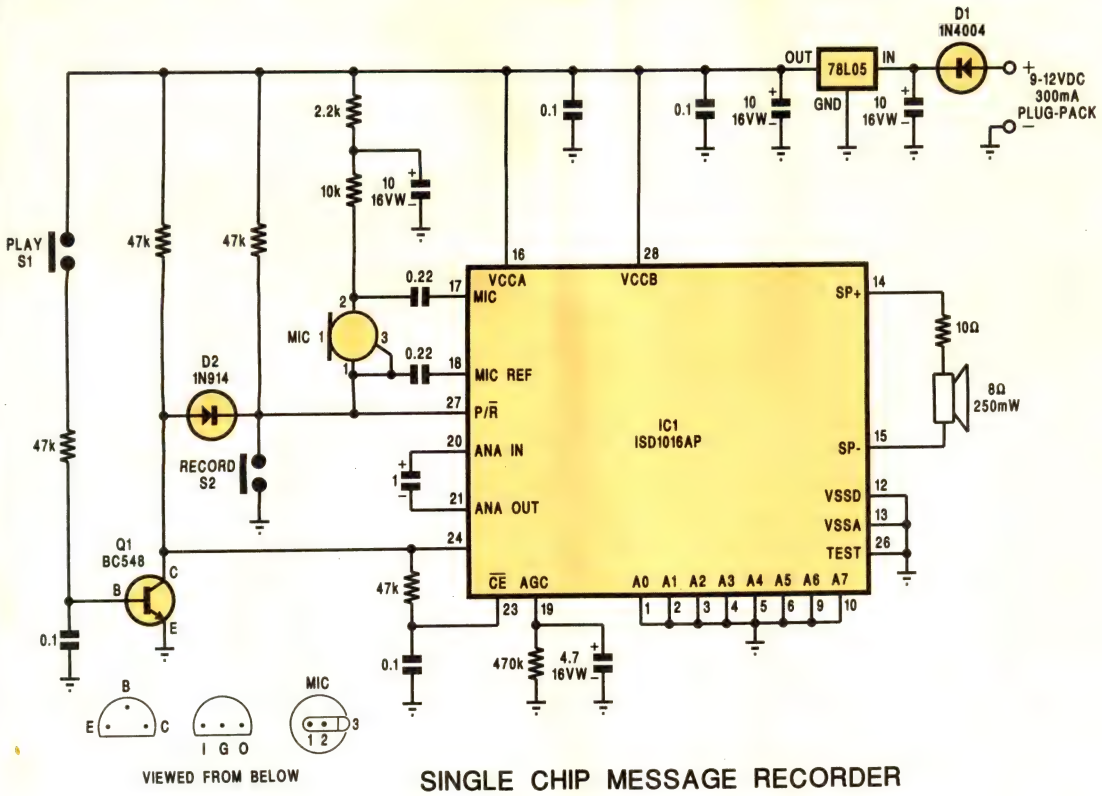
There's no need for a power switch on the unit either. When not in use, the IC automatically powers down into a stand-by mode and typically draws less than 1μA.

The frequency response of the recorder is about 80-3400Hz, which is about the same as telephone quality. It has a total harmonic distortion of typically 2% at 1kHz and the operating current is 25mA @ 5V.

Of course, there are other applications for the device apart from its obvious role as a message recorder. For example, by using the Playback button as a bell-push, it could be used as a doorbell. Alternatively, it could be built into an answering machine, or into machinery and used to deliver instructions in response to user inputs.

Single chip design

The new IC used in the Message Recorder is designated ISD1016A and comes from Information Storage Devices in the USA. It uses analog rather than digital technology and includes a microphone preamplifier, 128K cell EEPROM and an audio output amplifier which can directly drive a loudspeaker.



SINGLE CHIP MESSAGE RECORDER

Fig.1: the circuit is based on IC1 – an ISD1016A single chip message recorder. When the RECORD button is pressed, signals picked up by the microphone are fed into IC1 & stored in an internal EEPROM. Pressing the PLAY button switches the chip to playback mode.

During recording, this device samples the incoming audio signal and stores these samples as analog voltages in the EEPROM. This technique is more efficient than digital storage and provides the added bonus of 10-year zero-power data retention.

If necessary, individual devices can be cascaded to obtain longer recording times. The chip also has a message addressing facility so that individual messages can be repeated or different messages played back. We haven't used these features here though, to keep the circuit as simple as possible.

For detailed information on the ISD1016AP IC, take a look at the feature article on this chip elsewhere in this issue.

Circuit details

Let's now take a look at the circuit diagram of the Message Recorder – see Fig.1. As you can see, there's not much to it – just the IC, a microphone, a loudspeaker, and a handful of minor parts.

As soon as power is applied to the circuit, IC1 goes into "power down" mode. This occurs because the POWER DOWN pin (pin 24) is pulled high by a 47kΩ resistor. The current drawn from the supply is then just the current required to run the 78L05 5V regulator – about 4mA.

When the RECORD button is pressed, the PLAY/REC pin (pin 27) is pulled low, while the POWER DOWN pin (pin 24) is pulled low via diode D2. The CHIP ENABLE pin (pin 23) is also pulled low – via a 47kΩ resistor and D2 – so that the IC can now accept an audio input.

Finally, pressing the RECORD button also turns the electret microphone on. This now picks up sound and feeds an audio signal into a preamplifier stage inside the IC at pin 17.

The 470kΩ resistor and 4.7µF capacitor on pin 19 set the AGC time constant for the microphone preamplifier. The aim here is to achieve the highest level of audio possible without clipping, to keep the signal-to-noise ratio as high as possible.

The 1µF capacitor between pins 21 & 20 couples the audio signal from the preamplifier to an internal amplifier block. From there, the signal passes via an anti-aliasing filter and is clocked into the 128K cell analog storage array.

All clock and timing functions are carried out automatically inside the chip, so no external clock components are required.

The chip continues to record the signal on its pin 17 input until either the RECORD button is released or the device runs out of memory.

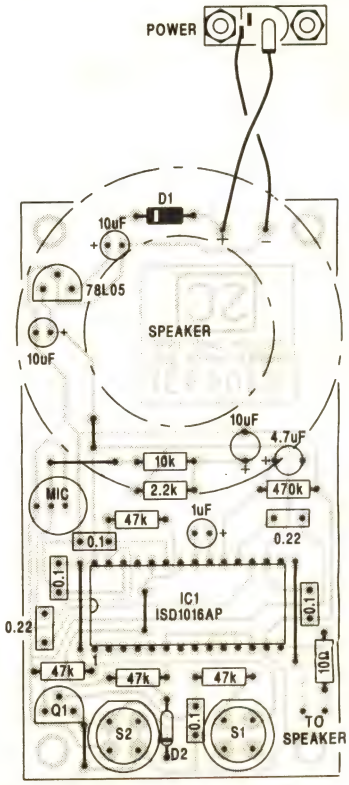


Fig.2: note the orientation of switches S1 & S2 when installing them on the PC board. The flat side of each switch body faces towards IC1.

When the PLAYBACK button (S1) is pressed, Q1 turns on and pulls the POWER DOWN pin (pin 24) low to bring the chip back "on line". At the same time, D2 prevents the PLAY/REC pin from being pulled low again since this diode is now reversed biased. This means that the internal recording circuitry remains disabled.

The recorder now replays the message stored in its memory. If the PLAYBACK button is released during playback, the message stops. If the button is then pressed again, the message restarts from the beginning.

The audio output signal appears across pins 14 & 15 (SP+ and SP-). These are complementary outputs which provide 50mW of power into a 16Ω load. Since we are using an 8Ω loudspeaker, a 10Ω resistor is installed in series with the output to provide the correct load.

In order to keep digital "noise" to a minimum, the analog and digital sections of the circuitry have been isolated by providing separate ground return rails on the PC layout. This helps prevent digital noise from finding its way into the low-level audio sections, such as the preamplifier and the AGC circuitry.

The circuit requires a 5V supply and this is derived via reverse polarity protection diode D1 and a 78L05 3-terminal regulator. Power is derived from the mains via either a 9V or 12V DC plugpack.

PARTS LIST

1 PC board, code 01104931, 100 x 55mm
1 green snap action pushbutton switch (S1)
1 red snap action pushbutton switch (S2)
1 plastic zippy case, 130 x 67 x 42mm
1 57mm 8Ω loudspeaker
1 electret microphone insert
4 15mm-long x 3mm tapped spacers
8 6mm-long x 3mm machine screws
4 3mm nuts
8 PC stakes

Semiconductors
1 ISD1016AP sound recorder IC (IC1)
1 78L05 5V regulator
1 BC548 NPN transistor (Q1)
1 1N4004 silicon diode (D1)
1 1N914 signal diode (D2)

Capacitors
3 10µF 16VW electrolytic
1 4.7µF 25VW electrolytic
1 1.0µF 63VW MKT polyester
2 0.22µF 63VW MKT polyester
4 0.1µF 63VW MKT polyester

Resistors (1%, 0.25W)
1 470kΩ, 1 2.2kΩ, 4 47kΩ, 1 10Ω, 1 10kΩ

Miscellaneous
Light-duty hook-up wire, tinned copper wire (for links), epoxy resin.

Fig.3: this full-size artwork can be used as a drilling template for the front panel.

Construction

All the parts for the Message Recorder – including the loudspeaker – are installed on a small PC board. This board is coded 01104931 and measures 100 x 55mm.

Before starting construction, check the PC board for etching defects by comparing it with the published pattern. If you find any, correct the problem immediately. Fortunately, etching defects are fairly uncommon but it's always wise to make sure.

When you're sure that everything is OK, you can begin by installing the five wire links – see Fig.2. Make sure that the link wires are straight so that they don't short against other components and note that one link runs under IC1.

CAPACITOR CODES

❑	Value	IEC Code	EIA Code
❑	1.0µF	1u0	105
❑	0.22µF	220n	224
❑	0.1µF	100n	104

RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	4	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	10Ω	brown black black brown	brown black black gold brown

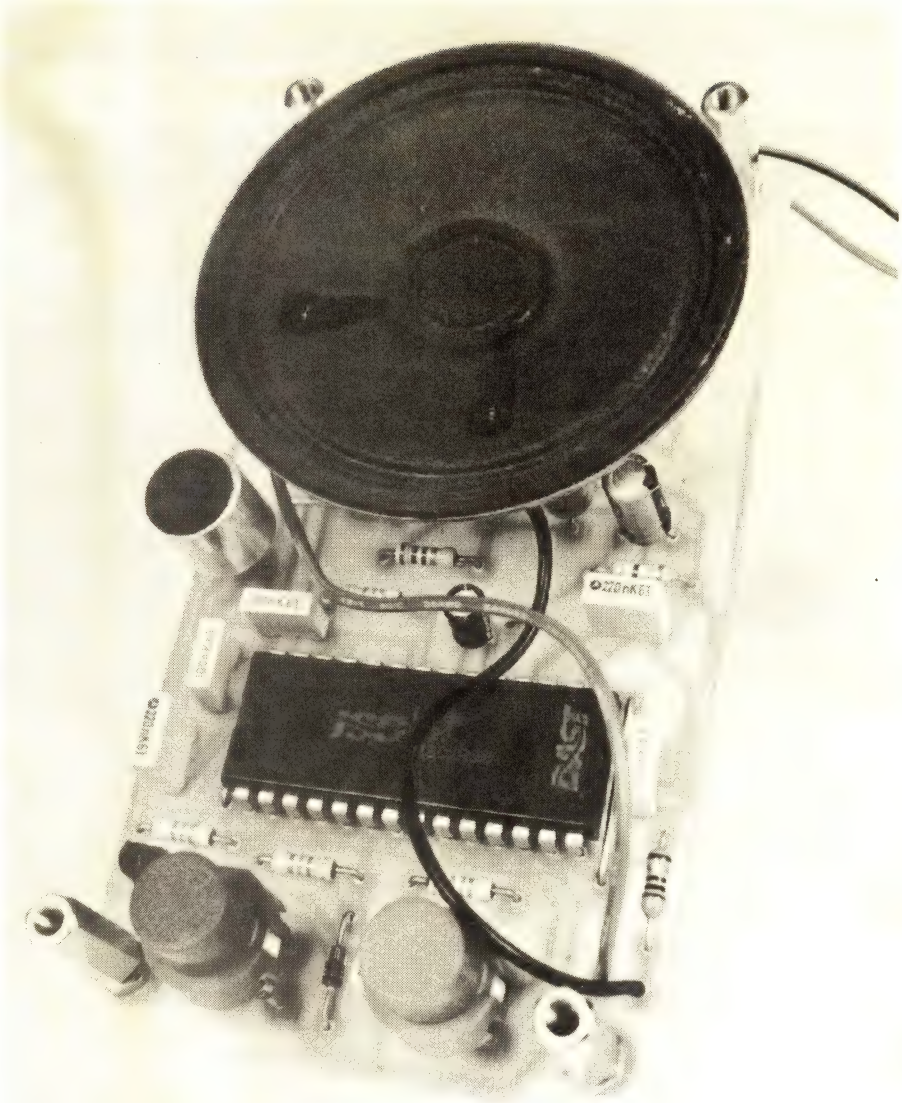
Once the links are in, install PC pins at each of the switch mounting pads and at the microphone mounting pad nearest the edge of the board (note: not needed for a 2-terminal microphone). This done, the resistors, capacitors and semiconductors can all be installed on the board. The accompanying table shows the resistor colour codes but it's also a good idea to check each resistor with your multimeter before installing it, as it can be difficult to distinguish the colours on some brands.

Pay particular attention to the orientation of the polarised components. These include the electrolytic capacitors and the semiconductors. Pin 1 of the IC is adjacent to a small notch in one end of the plastic body.

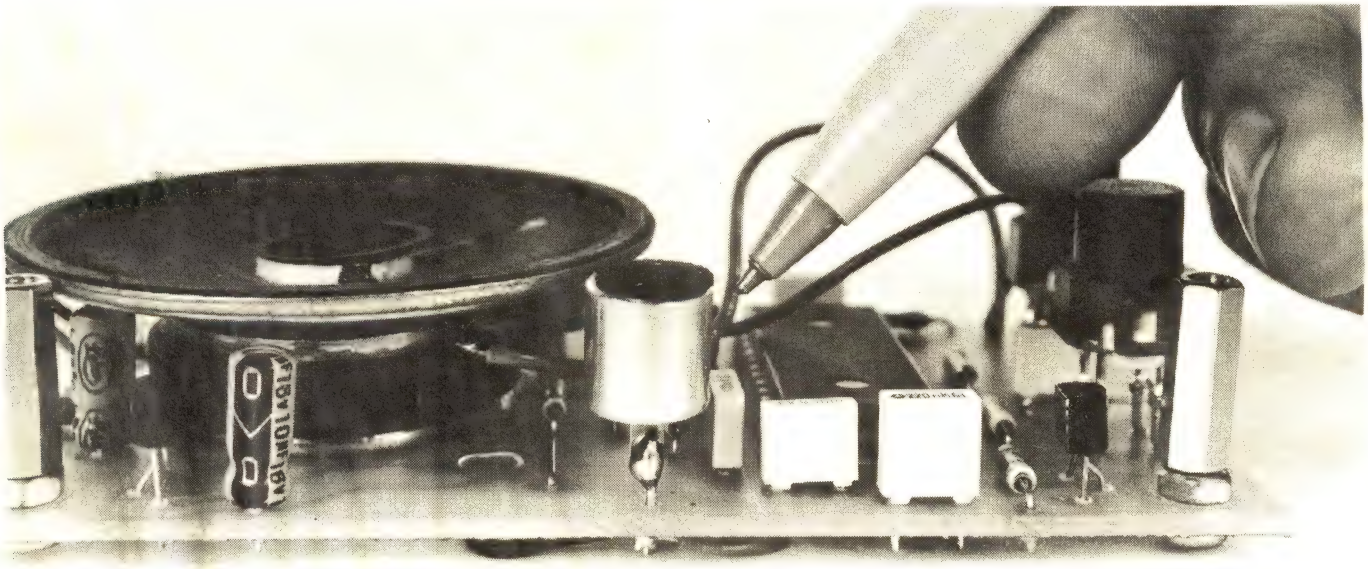
The two pushbutton switches (red for RECORD, green for PLAYBACK) can now be soldered to the tops of the PC stakes (see photo). To do this, first lightly tin the PC stakes and switch pins, then position the switches on the PC stakes and heat the contact points with a soldering iron to re-melt the solder.

Note that the switches must be oriented exactly as shown on Fig.2 – ie, with the flat side of each switch body towards IC1.

The electret microphone insert is mounted with its top surface about 16mm above the PC board. If it is a 3-terminal device, it should be oriented so that its outer shield connection is soldered to the PC stake previously installed. If it is a 2-terminal device, ignore the outer shield connection. In both cases, the positive terminal goes



Make sure that all polarised parts are correctly oriented when installing them on the PC board. The loudspeaker is mounted using double-sided tape or epoxy resin, while the microphone is mounted with its top surface about 16mm above the PC board – see photo below.



to the centre of the three pads.

Finally, complete the PC board by installing four mounting spacers (each consisting of a 15mm spacer and a nut) and then mounting the loudspeaker in position. The loudspeaker can be affixed to the board using double-side tape or epoxy resin.

Use light-duty hook-up wire to connect the output terminals on the PC board to the loudspeaker terminals. Similarly, connect two 120mm-long flying leads to the power supply terminals – these will later be wired to the DC power socket.

Final assembly

The completed board assembly can now be installed in the specified plastic case. To do this, first attach the adhesive label and use it as a drilling template for the front panel. You will have drill four mounting holes for the PC board, two clearance holes for the switches and access holes for the loudspeaker and microphone.

In addition, you will have to drill mounting holes in one end of the case to accept the DC power socket. This hole should be positioned near the bottom of the case, so that the socket doesn't foul the PC board.

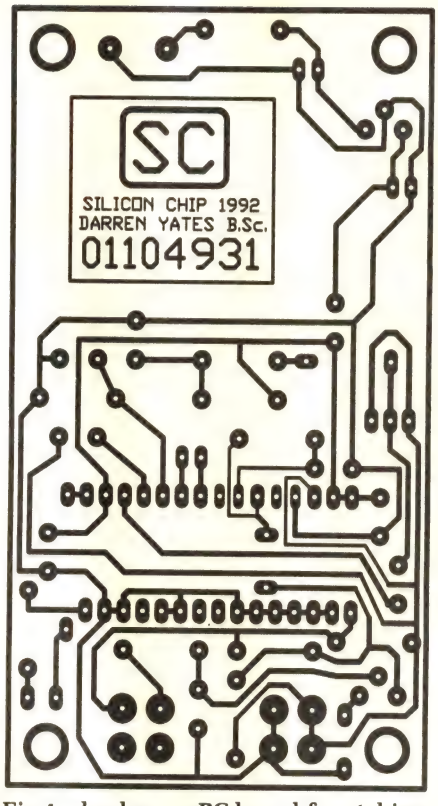


Fig.4: check your PC board for etching defects by comparing it against this full-size pattern before mounting any of the parts. In particular, check the tracks that run between IC pads.

After that, it's simply a matter of attaching the board to the lid and connecting the supply leads to the DC input socket. Before doing this though, connect the plugpack supply and use your multimeter to identify the positive and negative terminals on the back of the socket. The supply can then be disconnected and the leads soldered to their respective terminals.

Testing

To test the unit, apply power and hold down the RECORD button while you speak into the microphone. Now check that the message replays when you press the PLAYBACK button.

If it doesn't work, first check for +5V at the output of the 3-terminal regulator. Check also that this voltage appears on pins 16 & 28 of the IC. If these checks prove OK, check that pin 24 switches from +5V to almost 0V when the PLAYBACK button is pressed. If it doesn't, check the circuit around Q1.

Finally, if your microphone is a 2-terminal device, check that it is correctly oriented, with the positive terminal going to the centre pad. **SC**

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26 Lambourn Road, Watsonia, Vic 3087.

LED BRAKE LIGHT INDICATOR

This "brilliant" brake light indicator employs 60 high intensity LEDs (550-1000mCd) to produce a display that is highly visible, even in bright sunlight. The intensity produced is equal to or better than the LED brake indicators which are now included in some late model "upmarket" vehicles. The LED displays used in most of these cars simply make all the LEDs turn ON every time the brakes are applied. The circuit used in this unit can perform in this manner and, for non-automotive applications, it can also be customised to produce a number of sweeps (1-10) starting at the centre of the display and with a variable sweep rate. It not only looks spectacular but also attracts more attention.

All the necessary "electronics" is assempled on two identical PCBs and the resulting overall length of the twin bargraph display is 460mm. Note that the LEDs don't require matching! It's very simple to install into a car since only two connections are required: Earth and the brakelight connecting wire.

The case for the prototype unit which would be suitable for mounting on the rear parcel shelf, was mainly made from two aluminium "L" brackets that were screwed together to make a "U" section. A metal rod and its matching holders, which are commonly available from hardware shops were used for the supporting leg.

$ 65

for both the PCBs, all the onboard components and instructions: Yes, the 60 LED's are included!

We also have available a similar kit that does not have the sweeping feature. It produces similar results to the commercial units installed in cars: all the LEDs light up when power is applied.

$47

for both the PCBs and all the onboard components. This kit is also supplied with the 60 LEDs and it uses different PCBs, that have identical dimensions to the ones supplied in the above-mentioned kit.

5-INCH COLOUR MONITOR

These brand new open frame construction 5-inch colour monitors have a flat faceplate, 640 x 200 dot resolution, CGA and Hercules compatible, standard interface connector, degaussing coil included, 12V DC operation, 15.75kHz horizontal frequency, 60Hz vertical frequency. These frequencies are both adjustable to the Australian standard TV frequencies: information supplied. Use them for computer monitors, experimenting, education, disco displays etc. Don't miss out on this BARGAIN!:

$ 149

HIGH POWER TRIACS

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TV TUNERS

These famous brand TV tuners were intended to convert some colour computer monitors to colour TV receivers. The monitors have a composite video input – not RGB. They contain all of the necessary signal processing and channel switching: Antenna In to Composite Video and Line Level output. They are a commercial product which is completely enclosed and mains powered. Channels are selectable by 12 illuminated pushbutton switches in the VHF-UHF range. Supplied with a "rabbit ears" antenna. A circuit for the unit is provided. We should have more information and circuits showing how to convert the composite video output to an RGB output and how to convert the unit to a stereo tuner. LIMITED SUPPLY.

$149

BLUE LEDS

Not just any BLUE LED. This one has an output of 4.8-8mCd @ 20mA: (That is bright when considering that a normal red LED has an output of approx. 0.5mCd). Forward voltage of 2.5-3.5V, BLUE (470nm) output. SUPER PRICE:

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LCD CHARACTER DISPLAYS

We sold out of these new 16-character by 2-line alphanumeric LCD display modules but have obtained new stocks recently. They have surface mount control circuitry mounted on the rear of the display and only require a few mA at 5V to operate: information included. Although they have different pin positioning, they can be used directly with the project published in SILICON CHIP entitled Alphanumeric LCD Display Board: see May 1993 issue. New units at about 1/2 of their real value:

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$180 WITH 5mW TUBE
$280 WITH 10mW TUBE

GREEN LASER HEADS

We have a limited quantity of some brand new 2mW+ laser heads that produce a brilliant green output beam. Because of the relative response of the human eye, these appear about as bright as 5-8mW red helium neon tubes. Approximately 500mm long by 40mm diameter, with very low divergence. Priced at a small fraction of their real value.

$599

A 12V universal laser inverter kit is provided for free with each head.

LED DISPLAYS

National Semiconductor 7-segment common cathode 12-digit multiplexed LED displays with 12 decimal points. Overall size is 60 x 18mm and pinout diagram is provided.

2.50 Ea. or 5 for $10

BATTERIES

Brand new industrial grade PANASONIC 12V-6.5Ah sealed gel batteries at a reduced price. Yes, 6.5Ah batteries for use in alarms, solar lighting systems, etc. Dimensions: 100 x 954 x 65mm. Weight of one battery is 2.2kG. The SPECIAL price?

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PROJECTION LENS

Brand new large precision projection lens which was originally intended for big screen TV projection systems. Will project images at close proximity onto walls and screens and it has adjustable focussing. Main body has a diameter of 117mm and is 107mm long. The whole assembly can be easily unscrewed to obtain three very large lenses: two plastic and one one glass. The basis of a high quality magnifier or projection system? Experimenters delight!

$30

CRYSTAL OSCILLATOR MODULES

These small TTL Quartz Crystal Oscillators are hermetically sealed. Similar to units used in computers. Operate from 5V and draw approximately 30mA. TTL logic level clock output. Available in 4MHz, 4.032MHz, 5.0688MHz, 20MHz, 20.2752MHz, 24.74MHz, 40MHz and 50MHz.

$7 Ea. or 5 for $25

FLUORESCENT BACKLIGHT

These are new units supplied in their original packing. They were an option for backlighting Citizen LCD colour TVs. The screen glows a brillant white colour when the unit is powered by a 6V battery. Draws approximately 50mA. The screen and the inverter PCB can be seperated. Effective screen size is 38 x 50mm.

$12

MASTHEAD AMPLIFIER KIT

Based on an IC with 20dB of gain, a bandwidth of 2GHz and a noise figure of 2.8dB, this amplifier kit out performs most other similar ICs and is priced at a fraction of their cost. The complete kit of parts for the masthead amplifier PCB and components and the power and signal combiner PCB and components is PRICED AT AN INCREDIBLE:

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For more information see a novel and extremely popular antenna design which employs this amplifier: MIRACLE TV ANTENNA - EA, May 1992: box, balun and wire for this antenna - $5 extra.

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Brand new 140W low pressure sodium vapour low pressure lamps. Overall length 520mm x 65mm diam. GEC type SO1/H. We supply data for a very similar lamp (135W). CLEARANCE AT:

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These are brand new units, main body has a diameter of 58mm and a height of 25mm. Will operate from 5V, has 7.5-degree steps, coil resistance of 6.6 ohms, and it is a two phase type: six wires. ONLY:

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6.5Ahr. PANASONIC gel Battery $35, ELECTRIC FENCE PCB and all onboard components kit $40. See SC April 93.

LARGE LCD DISPLAY MODULE - HITACHI

These are Hitachi LM215XB, 400 x 128 dot displays. Some are silver grey and some are yellow green reflective types. These were removed from unused laptop computers. We sold out of similar displays that were brand new at $39 each but are offering these units at about half price. VERY LIMITED STOCK.

$40

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3kV PIV - 300mA / 30A Pk fast diodes 60c
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Yes 100 LEDs plus IC control circuitry, all surface mounted on a long strip of PCB. SIMPLE - a 4-bit binary code selects which one out of the 10 LED groups will be on, whilst another 4-bit binary code selects which one of each group of 10 LEDs will be ON. Latching inputs are also provided. We include a circuit and a connecting diagram. VERY LIMITED QUANTITY

$7Ea.

FM TRANSMITTER KIT - MKII

This low cost FM transmitter features pre-emphasis, high audio sensitivity, a range of well over 100 metres, etc. It also has excellent frequency stability. The resultant frequency shift due to waving the antenna away and close to a human body and/or changing the supply voltage by ±1V at 9V will not produce more than 30kHz deviation at 100MHz! That represents a frequency deviation of less than 0.03%, which simply means that the frequency stays within the tuned position on the receiver.

Specifications: tuning range: 88-101MHz, supply voltage 6-12V, current consumption @9V 3.5mA, pre-emphasis 50µs or 75µs, frequency response 40Hz to greater than 15kHz, S/N ratio greater than 60dB, sensitivity for full deviation 20mV, frequency stability 0.03%, PCB dimensions 1-inch x 1.7inch. Construction is easy and no coil winding is necessary. The coil is preassembled in a shielded metal can. The double sided, solder masked and screened PCB also makes for easy construction. The kit includes a PCB and all the on-board components, an electret microphone, and a 9V battery clip:

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Build this light beam relay extender

This simple infrared transmitter circuit is designed to go with the Light Beam Relay project published in the December 1991 issue. It's based on a 555 timer IC & will more than double the effective range.

By DARREN YATES

The Light Beam Relay published in our December 1991 issue has proven to be a popular project. In most applications, it is used to monitor a path or a doorway (eg, to a shop) using an invisible infrared light beam. When someone walks through the beam, it briefly sounds an alarm.

To simplify construction, the original project housed the transmitter and receiver circuits in the one case. This meant that the infrared light from the transmitter had to be reflected back to the detector in the receiver using a mirror mounted on the opposite side of the doorway.

But what if you want greater range, or a unit that can be moved to another location and quickly set up without critical alignment? The answer is to disable the internal transmitter circuit and use this external transmitter circuit (or Light Beam Relay Extender) instead. It uses a 555 timer IC and a transistor to pulse two IR LEDs at a frequency of about 2kHz.

This external circuit increases the working range to about five metres – 2.5 times that of the original. That's mainly because the light no longer travels over a double path length and because scattering losses at the mirror are eliminated (since the mirror is no longer required).

Further improvements in the range are derived from increasing the gain of the receiver and by moving the detector diode (D2) right up to its viewing hole in the side of the case. These last two modifications must not be applied to the original project however, as this would cause false triggering due to the close proximity of the IR LEDs and the detector.

Refer now to Fig.1 for the circuit details. IC1 is a 555 timer and is connected as an astable oscillator. Its frequency of oscillation is about 2kHz, while the duty cycle of the output waveform at pin 3 is about 100:1.

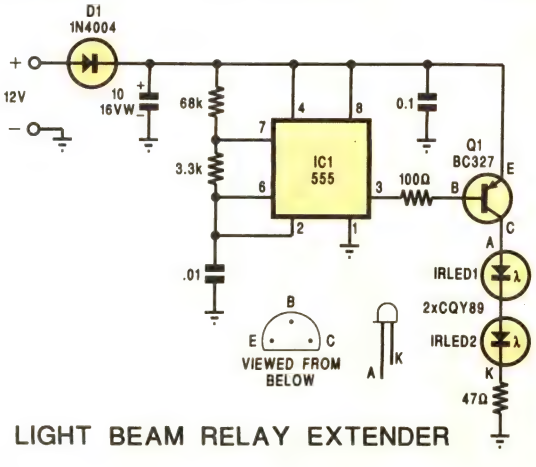
The output signal at pin 3 drives transistor Q1 via a 100Ω current limiting resistor. Since Q1 is a PNP type, it only turns on during the narrow low-going pulses from pin 3 (ie, its duty cycle is about 1%). Each time Q1 turns on, about 200mA is pulsed through the two IR LEDs to turn them hard on. Although this may seem a very high current, the LEDs are only on for about 1% of the total time and so the current averages out to about 2mA which is well within their rating.

Power for the circuit is derived from the same source that's used to power the receiver (ie, a 12V DC plugpack). Diode D1 provides reverse polarity protection, while the 10µF capacitor provides supply line decoupling.

Construction

All the parts for the Light Beam Relay Extender are installed on a small PC board coded 03106931. Fig.2 shows the parts layout.

No particular order need be followed when installing the parts but take care to ensure that all polarised parts are correctly oriented. These in-



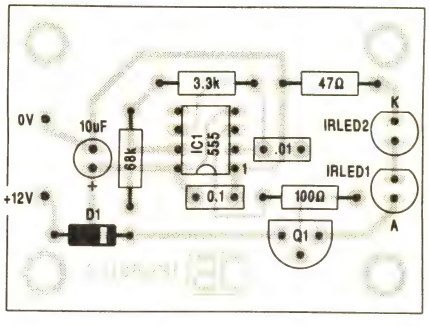
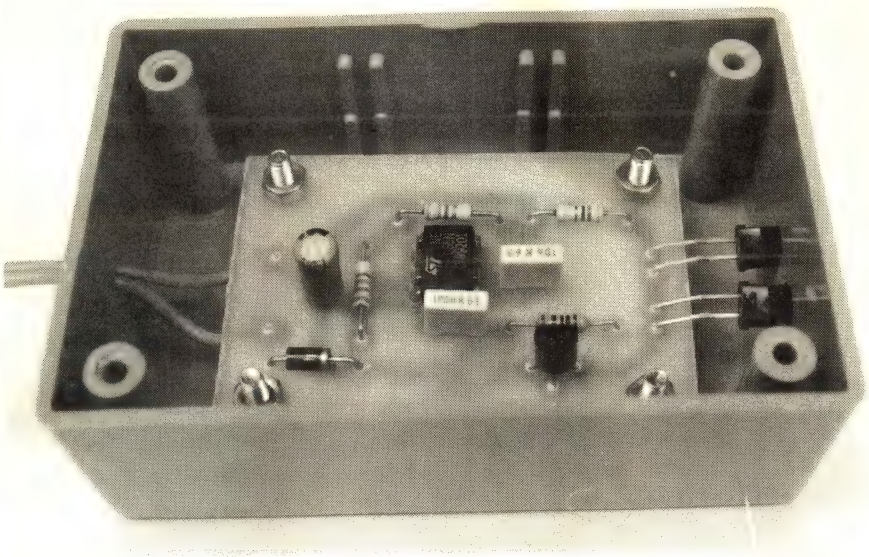


Fig.1 (left): the circuit uses astable oscillator IC1 (555) to pulse two IR LEDs on & off via driver stage Q1. Fig.2 (above) shows how the parts are installed on the PC board. Make sure that the LEDs are correctly oriented.



The PC board fits inside a small plastic utility case, with the two IR LEDs protruding through holes drilled in one end.

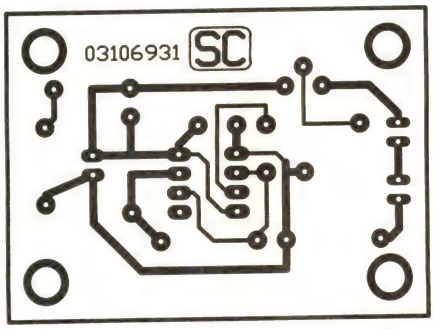


Fig.3: the full-size etching pattern for the PC board.

clude the two IR lEDS, the semiconductors and the 10µF electrolytic capacitor. Mount the two LEDs at full lead length so that they can later be bent to protrude through one end of the case.

A small plastic utility case is used to house the transmitter circuit. Drill two holes in one end for the LEDs plus four mounting holes in the base, then secure the PC board using machine screws and nuts.

Power for the transmitter circuit can be obtained by running a long lead back to the DC socket inside the receiver. This lead can be hidden by running it over the top of a doorway, for example. Alternatively, you can power the transmitter from a separate plugpack supply.

Receiver modifications

In order for the extender circuit to do its job, you need to disable the transmitter in the original project. This is done by removing the 100kΩ resistor between the +12V supply rail and pin 2 of IC1. If you are building the project from scratch, just leave out the transmitter components around IC1a. You should also connect pin 2 of IC1 to ground and connect pins 1 & 3 together.

The gain of the receiver circuit is increased by reducing the 10kΩ resistor on pin 9 of IC1c to 1kΩ. Note that you can save a few dollars by transferring the IR LEDs to the external transmitter circuit. SC

PARTS LIST

1 PC board, code 03106931, 56 x 41mm.
1 plastic case, 83 x 54 x 30mm

Semiconductors
1 NE555 timer IC (IC1)
1 BC327 PNP transistor (Q1)
1 1N4004 silicon diode (D1)
2 CQY89A infrared LEDs (IRLED1, IRLED2)

Capacitors
1 10µF 16VW electrolytic
1 0.1µF MKT polyester
1 .01µF MKT polyester

Resistors (1%, 0.25W)
1 68kΩ
1 3.3kΩ
1 100Ω
1 47Ω

Miscellaneous
Hook-up cable for power leads, machine screws & nuts.

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SERVICEMAN'S LOG

When it looks easy, it often ain't

Yes, it did look easy. There it was; an obviously damaged component clearly visible. All I had to do was find out why it was damaged. Although this would involve some searching, it turned out to be a much bigger search than anyone could have imagined.

One of the most elementary methods of servicing has always been visual observation. Way back in the very early days of radio, when bright emitter valves were the norm, the first thing one looked for in a dead set was whether all the valves were alight. In fact, there were those who bemoaned the advent of the dull emitter valves, significantly more economical though they were, because they no longer provided this visual clue.

Much has changed since then of course, but the visual clue remains a valuable one, even with today's technology. The burn marks on a PC board, the bulging capacitor, the blackened fuse, the burnt resistor; they all pinpoint a fault area. And while they don't necessarily pinpoint the fault itself, they can show one where to start looking.

All of which is leading up to a particularly frustrating problem I encountered recently; the more so because at first glance – literally – there was a typical visual clue which should have put me straight on the right track.

It all started when the customer turned up with a Samsung colour set, model CB-5012Z. This is a 51cm set using a P/58SC type chassis and was about three years old. The complaint was straightforward enough; the set was completely dead, having simply failed in the middle of a program.

So, at the first opportunity, I put it up on the bench. I didn't bother to switch it on but simply pulled the back off and looked for any obvious clues. This was relatively easy because all the parts are on a single PC board, the only reservation being that the components in the power supply section are very tightly packed.

Two things were immediately obvious: (1) the mains fuse, F801 (3.5A), was blown; and (2) resistor R809 (270kΩ, 1W) was badly blackened. This resistor runs from the positive side of the bridge rectifier, at about 300V, to pin 4 of the switchmode power supply control IC, IC801 (TDA4601). And, as I subsequently discovered, safety resistor R801 (5.6Ω 7W) in the mains input line, just after the fuse, had also been sacrificed.

Splat No.1

Well, there was nothing very special about all that. Fairly obviously, there was a short that involved all three components and, as such, I didn't think that it would be hard to find. Anyway, the first thing to do was to replace the faulty resistors and I did this without even testing them. This done, I replaced the fuse and switched on with everything under close scrutiny.

Splat! There was a flash of flame, a puff of black smoke, and I had another blackened resistor. Fortunately, a fast reflex action by my switch finger saved the fuse and the safety resistor.

My initial thought was simply along the lines that a short at the IC end of R809 could produce such symptoms. I even went so far as to check for a short circuit between pin 4 of the IC and chassis; it was almost a reflex action. But then, on reflection, I realised that this didn't make sense. Even putting a 270kΩ resistor directly across 300V would dissipate only about one third of a watt.

So what was destroying the resistor?

All I could think of was that a much higher voltage, from somewhere else in the power supply, was finding its way to this resistor. But from where and by what means remained a mystery.

I went over the circuit around pin 4 of IC801 and resistor R809 but drew a complete blank. Finally, and somewhat against my better judgement, I decided that it must be a faulty IC. In any case, replacing it would prove the point, one way or the other.

The only snag was that I didn't have this particular IC in stock, so one had to be ordered. When it arrived a couple of days later, I lost no time in fitting it. This proved to be a somewhat tricky exercise due to the rather cramped conditions on this part of the board and the fact that the IC is mounted on a heatsink.

Splat No.2

Eventually, the job was completed

Light

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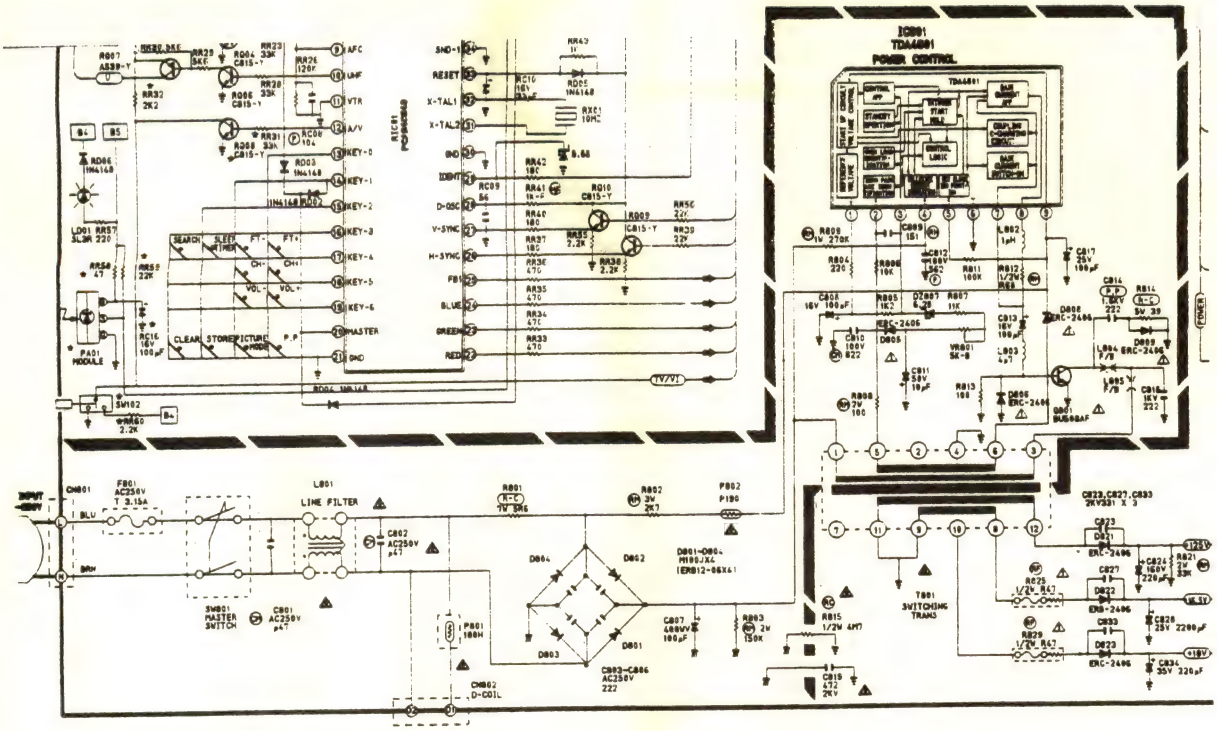


Fig.1: the power supply circuit for the Samsung CB-5012Z. Fuse F801 is at extreme left, safety resistor R801 to the right, & the bridge rectifier to the right again. R809 is below the lower left corner of IC801 at top right, while C816 is mid-way up the right-hand edge of the diagram.

and I made ready for another test. A new 270kΩ resistor had been fitted and I hoped all would go well this time. I pressed the power switch. Splat! Another flash of flame, another puff of smoke, and another blackened resistor. I gave up!

Well, almost but I certainly felt like it. Unfortunately, I had no choice but to keep at it and so, for want of a better approach, I simply began checking every component around the IC, either measuring then in-situ or removing them from the board for testing where necessary.

I had checked a dozen or more components in this way, without result, and was beginning to question the wisdom of this approach when I found myself in the vicinity of transistor Q801, the power supply switching transistor. This was removed and tested but also proved to be OK.

The next component was C816, a 222pF 1000V ceramic capacitor connected between Q801's collector and chassis. This component is obviously a spike suppressing device. Because of the associated circuitry around it, I decided that this it would also have to be removed for testing.

In fact, pulling it out was all the testing needed. It was mounted so close to other components that I could see only one side of it. But when I pulled it out and the other side became visible, I realised that I had struck oil. The case had split open to reveal a great black gaping crack.

So at last I'd found the real culprit. But what, you may ask, did it have to do with resistor R809, which appears to be in no way connected with this part of the circuit. And if you are thinking of way-out explanations involving spikes in Q801's collector circuit, forget it. Maybe there were some spikes but that isn't the explanation.

In fact, it was much more mundane than that and simply hinges on the proximity of C816 to R809. They were sitting side by side, virtually touching, with C816 lying slightly over the top of R809.

So the smoke and flame I had observed had come from C816, not R809. And the blackening of R809? This was almost certainly a burn – not from internal heat but from external heat generated by C816. Remember, I mentioned earlier that I had not even bothered to check the "damaged" resistors. That was a fatal mistake.

Had I done so, I would almost certainly have adopted a different approach. When I eventually checked all three of these resistors, they were spot on in value. There was nothing wrong with any of them. The damage was purely cosmetic and I had been well and truly conned.

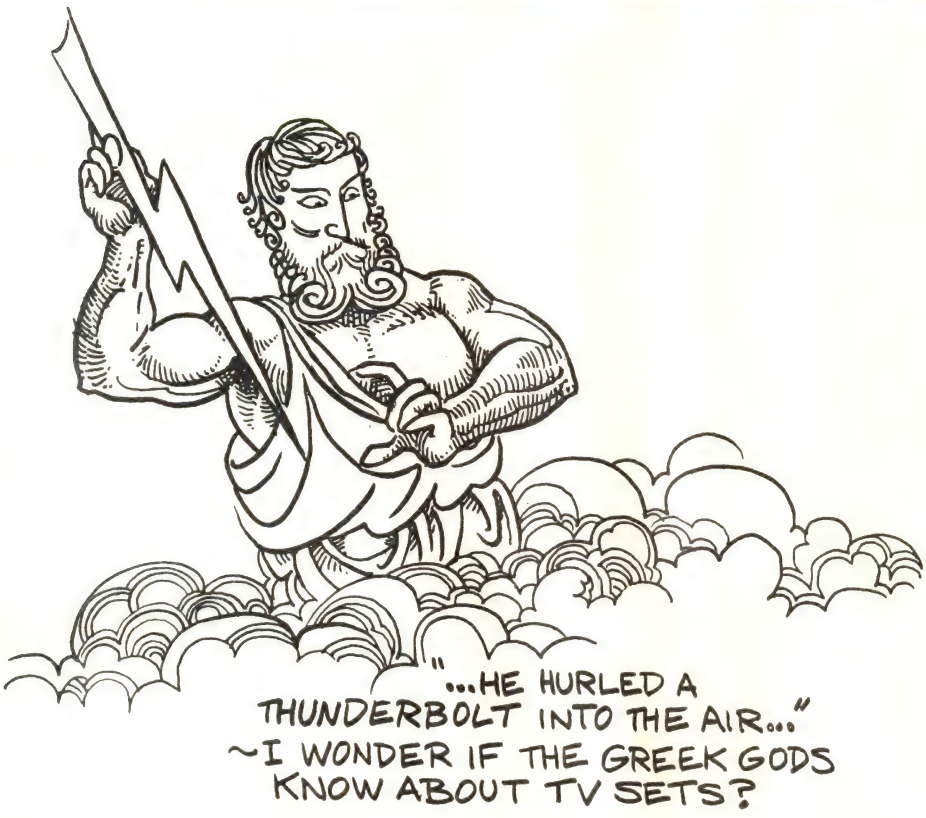
Rubbing in the salt

But there was still some salt to be rubbed into the wound. I replaced C816, fitted a new resistor for R809 purely for appearance, and switched on. And up came a perfect picture; the only thing that had ever been wrong with the set was C816. And it had carried a perfect visual clue but one which was impossible to see.

Had I been able to see it, I would have simply replaced the capacitor and the set would have been back in operation in a matter of minutes. As it was, I wasted hours on the job and, financially, it was a total disaster; something which had to be written off to experience.

In that sense, it wasn't a complete loss. Apart from the obvious lessons, one other point emerged. I realised that there was a failure pattern emerging concerning the C816 type capacitor.

Quite recently, I had also serviced a couple of Samsung chassis which carried the Akai label. Both suffered from the same fault – failure of a capacitor across the horizontal output transistor. And it was an identical capacitor: blue ceramic, 222pF, 1000V. In both



cases, they had simply developed a dead short and shut the set down without any fireworks. But from now on, I'm keeping my eye out for any faults which might involve this particular capacitor. It could well be less reliable than one expects from this type in general service.

Further to that observation, I have been able to secure another make of capacitor which I hope will be less troublesome than the originals. When I needed replacement capacitors for the Akai sets, it was more convenient to order them from an independent supplier rather than from Samsung. These not only carry a different brand but, more importantly, are rated at 2000V.

These new capacitors were fitted to the Akai sets, as well as to the Samsung set which was the subject of this month's story. Here's hoping that I have struck a blow for my customers.

Jupiter strikes

My next story is also about a Samsung set – a model CB-518F fitted with a P50HA chassis – and it also involves visual clues. But I must hasten to add that this problem was hardly the set's fault. No, the blame really lies with the great god Jupiter. In a fit of pique, "he hurled a thunderbolt into the air, which fell to earth he knew not where" (as they say in the classics).

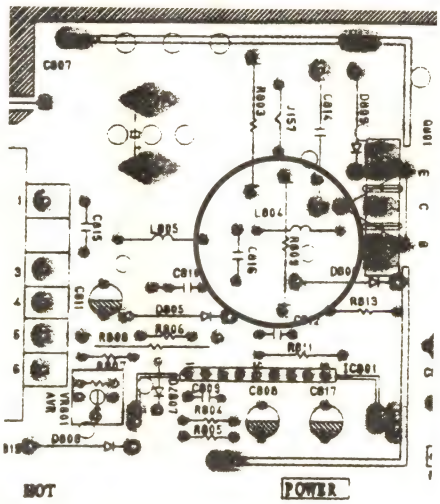


Fig.2: parts layout for the power supply in the Samsung CB-5012Z. R809 (circled) is situated between transistor Q801 on the right & C816 on the left. Note that, in practice, the board layout is much more crowded than this diagram indicates.

But my customer knew where; onto the power mains connected to his TV set. After that, the TV set didn't go any more. I wonder if the Greek gods know about TV sets?

OK, enough! But it was classic case of a mains lightning strike and this customer wasn't the only one affected. When I pulled the back off the set, the damage was plain to see.

The most obvious was the mains fuse, F801, 4A. The inside of the glass was totally blackened, suggesting a pretty violent strike, and I had no doubt that I would find more subtle damage as I went along.

The other visual clue involved a line filter, L801, in the mains lead immediately following the fuse. The filter coils themselves were undamaged but the white plastic case which enclosed them had been blown to pieces. Since it was still working, I decided to leave it until later.

The fuse was replaced and I moved on to the next item down the line: the bridge rectifier involving diodes D801-804. Two of these four diodes had snuffed it and these were replaced.

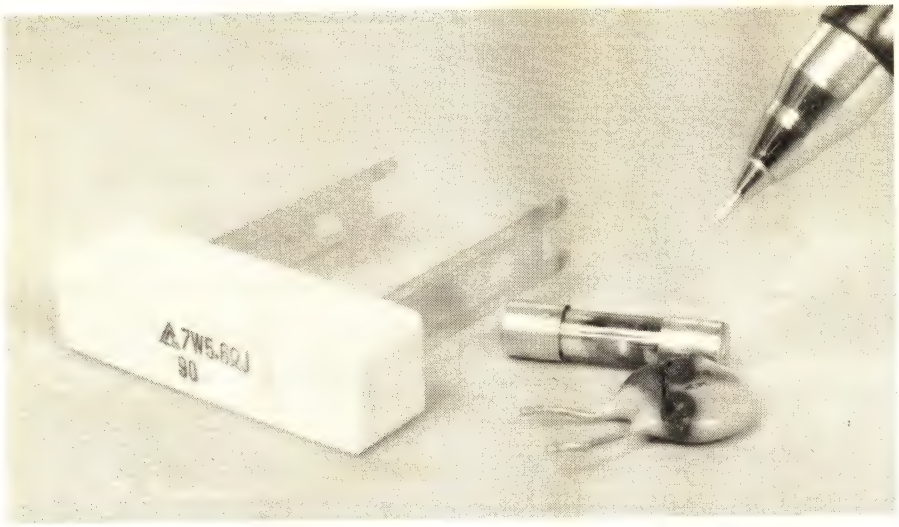
Switch-on

OK, time for a switch-on test. This left no doubt that there was more trouble ahead. There were loud protestations from the switchmode section of the power supply, suggesting a serious overload. I immediately checked the HT rail for any suggestion of a short to chassis but could find nothing wrong.

On this basis, and because all the faults so far had been at the input to the power supply, it seemed likely that the fault was still in this area. There are several more diodes in this section and I checked all these but found nothing wrong.

The next suspect was the regulator IC, Q801 (STR50103A). But before taking a final step in this direction, I made a few more checks. I was able to measure some HT rail voltage – about 68V as compared to the 103V shown on the circuit (pin 2 IC Q801 and TP103) – and I also checked the horizontal output transistor (Q404, 2SD-1555) but this appeared to be OK.

At that stage, I felt that I had gone as far afield as was reasonable for a strike of this kind, so I returned to the regulator IC. This is a small device, having only five pins, and I had one in stock so it was a simple matter to replace it.



This photo clearly shows the crack in the back of C816. Also shown in the blackened fuse (F801) and one of the replacement resistors used for R809.

But all that did was establish that there was nothing wrong with the original IC; the new one made no difference.

I made a few more checks and found that the 12V rail was down in about the same proportion as the HT rail loss. This 12V rail is derived from a 16.5V tap (pin 2) on the horizontal output transformer via diode D408 and resistor R225 (47Ω, 2W).

But there is also a 12V rail derived from the chopper transformer via diode D820, which is used as a starting supply to get the horizontal system running. And at this point I couldn't be sure which of these two supplies was powering the system, to the extent that it was working at all.

I also realised that, while all this analysis of the circuit was very interesting, it wasn't really revealing anything that might help solve the problem. It was time to change tactics.

Transistors cheat

Speculating on likely component failures, my thoughts came back to the horizontal output transistor, Q804. Granted, I had run the meter over it and decided that it was OK. But it wouldn't be the first time that such a transistor had cheated the testing procedure.

As always, and as they used to say in the old valve days, the ultimate test of a suspect device is to replace it. Which was what I did, it not being a particularly difficult procedure.

And that was it. The set was up and running in all its original glory. Which was both a relief and something of a let-down after all the chasing around the circuit.

And what about the line filter I mentioned earlier? While the coils were undamaged in any way, the white plastic cover was scattered in pieces around the inside of the cabinet. How come?

I found the answer quite by chance. The filter consists of two fine wire coils (or chokes) wound on small flat plastic bobbins, about the diameter of a 5-cent piece, but somewhat thicker. These in turn are mounted side by side on the centre leg of a rectangular ferrite core.

And I noticed, when switching the set on after it was repaired, that the switch-on surge, due to the degaussing circuit, caused the two coils to be pushed apart slightly, due to magnetic repulsion. They sat only loosely on the ferrite core.

The movement wasn't very great, and would not have caused any damage in the normal way. But with the massive surge that destroyed the bridge diodes and the fuse, the movement had obviously been much greater; enough to break the flimsy plastic cover. So that solved that particular mystery.

Unanswered questions

But that still leaves other questions unanswered. Why did such a massive surge, having destroyed the bridge diodes in that part of the circuit, skip over the regulator IC and the horizontal driver stage, to pick on the horizontal output stage? And why didn't it spread further via the supply rails and do a lot more damage?

More importantly, from a practical point of view, why did Q404 test OK when it wasn't?

I don't have any answers for the first two questions. I doubt whether anybody has – except Jupiter perhaps and he's not telling.

I don't have a complete answer to the third question either, but there seems little doubt that the protective devices in these transistors (ie, the diode between collector and emitter and the resistor between base and emitter) make them difficult to test reliably. The resistor, in particular (normally 35-40Ω), makes it difficult

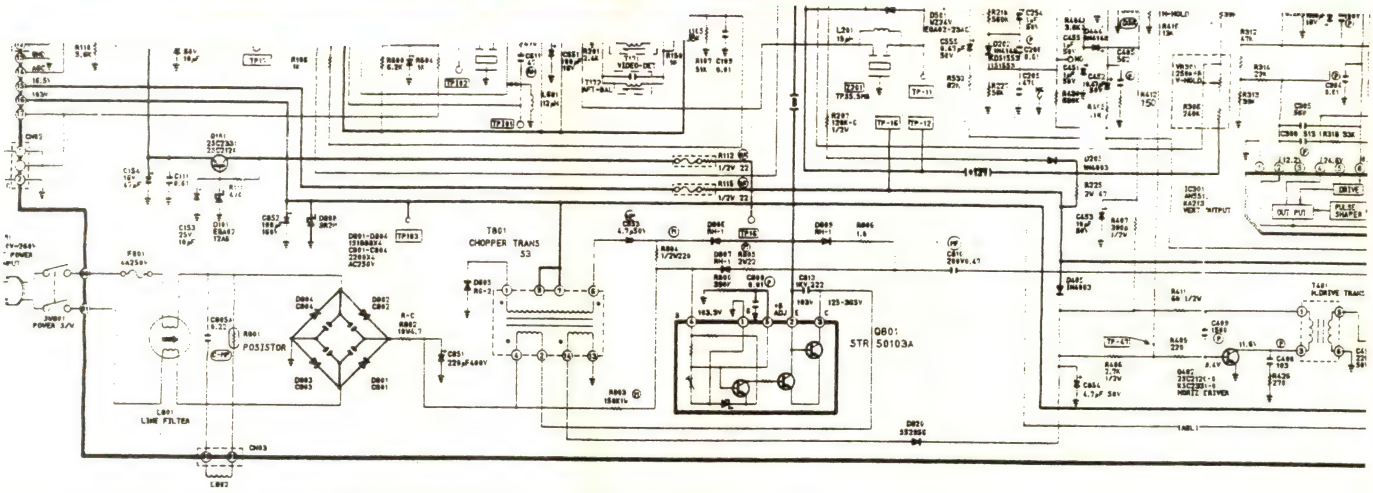


Fig.3: the power supply circuit for the Samsung CB-518F. The mains on/off switch is at the bottom left of the diagram. Fuse F801 follows, then the line filter L801, the degauss circuit L802, and bridge rectifier D801-804. Next in line is chopper transformer T801 then and switching IC Q801. The horizontal deflection circuit is at the top of the diagram.

to determine the condition of the base-emitter junction.

On the other hand, they don't always confuse the issue; sometimes faults are quite readily detected. It all depends on the nature of the failure. So the rule seems to be if it tests faulty, then it is faulty; if it tests OK, it might be faulty, or it might not.

Must try not to get caught like that again.

Circuit diagrams

One final comment. Unfortunately, the quality of the diagrams in many manuals leaves a lot to be desired, and the diagrams for the Samsung sets just discussed fall into this category. The main problem stems from the large size needed for many original drawings, followed by over reduction in an effort to accommodate them in a typical manual.

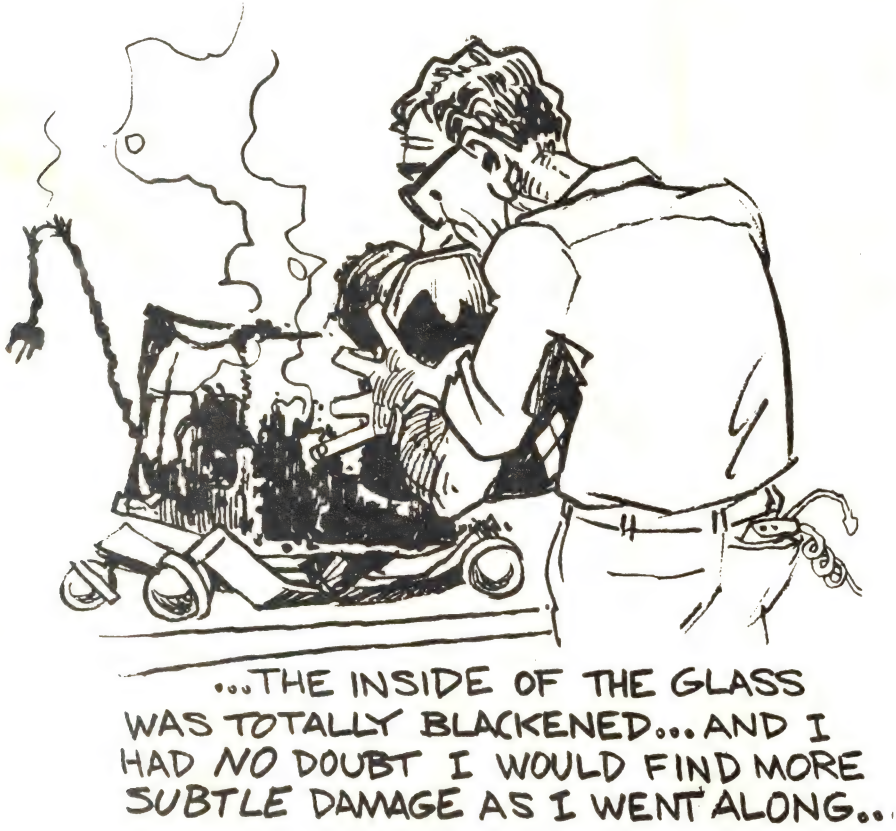
This can create major problems when trying to trace a circuit, while tracking down a difficult fault. Component values are often hard to read, particularly where figures 6, 8, 9 and even 0 (zero) are concerned. In a blurred reproduction, one can easily be mistaken for the other.

Even more confusion can occur where circuit lines cross. While the concept of using small circular blob to denote a connection, or no blob to denote a non-connective crossing, has the advantage of draughting simplicity, it falls down badly where the reproduction is poor.

A certain amount of image spread can occur where lines cross, creating the impression of a blob where none exists, or giving rise to doubts as to whether a genuine blob is really only a blur. And take my word for it; it can waste a lot of time.

Personally, I much prefer the more conservative drawing convention, which uses a loop to denote a non-connective crossing. The stated objection, of course, is that this requires more work and is therefore more costly. Well maybe it used to be but these days, with Computer Aided Drawing (CAD) programs, I doubt whether the difference is all that great.

Anyway, for my money, the difference is worth any extra cost. S



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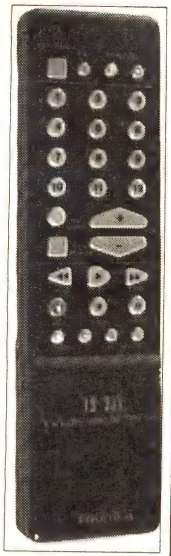

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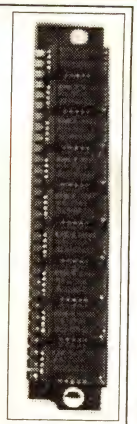

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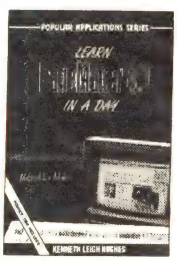

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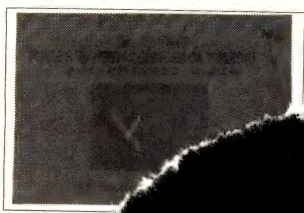

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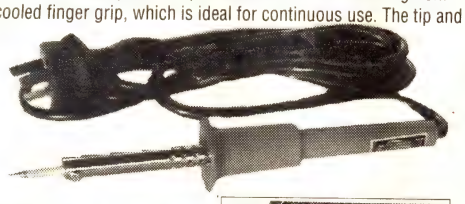

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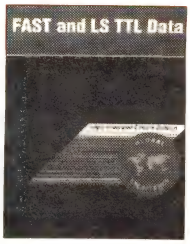

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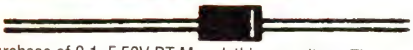

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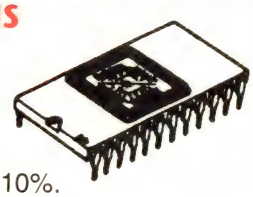

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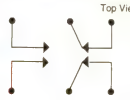

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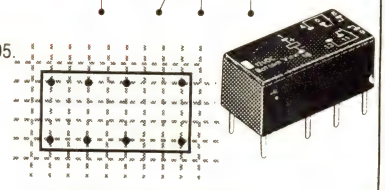

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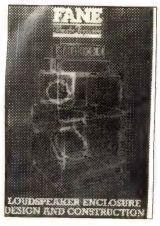

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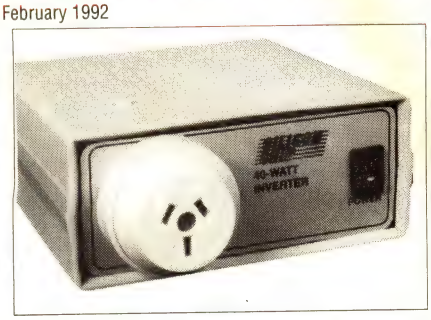
Ref: Silicon Chip February 1992



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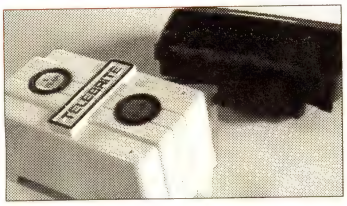

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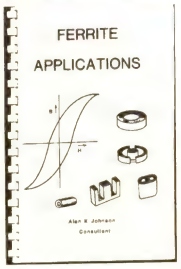

This is one subject that is very difficult to find any information on. Magnetic cores are the foundation for transformers, inductors and chokes used in so many of our electronic projects. This book is intended to be used by persons who want to (or have to) work with ferrite materials, but are not well versed in magnetics or ferrites and cannot justify outside consultation. Some of the problems addressed are:- • How to select the right type of material • How to identify an unknown material • How to measure material properties and much more. Written in 1991 by A. K. Johnson.

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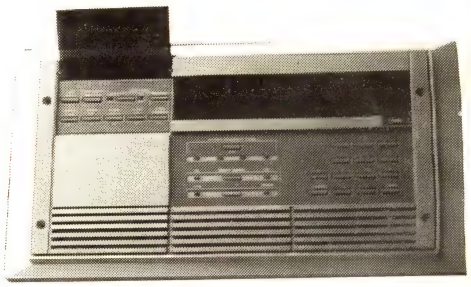

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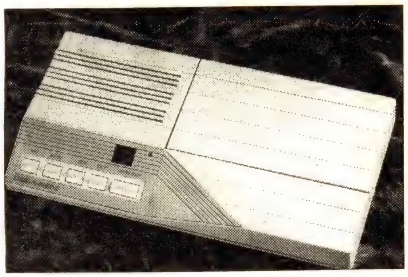

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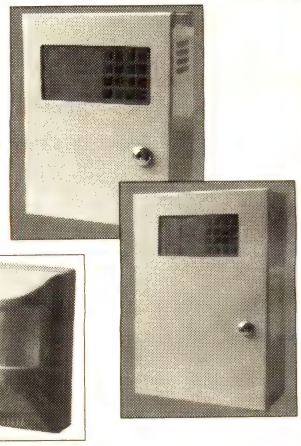

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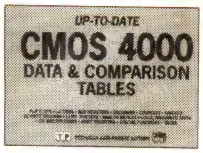

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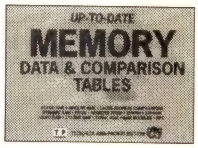

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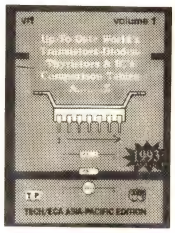

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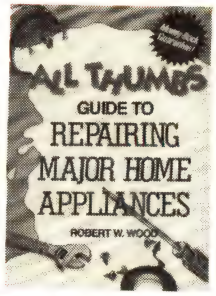

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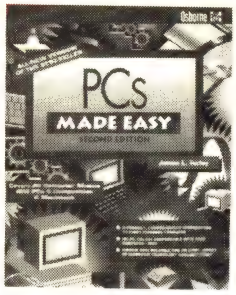

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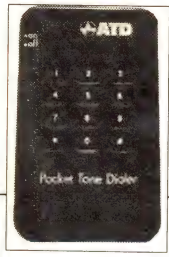

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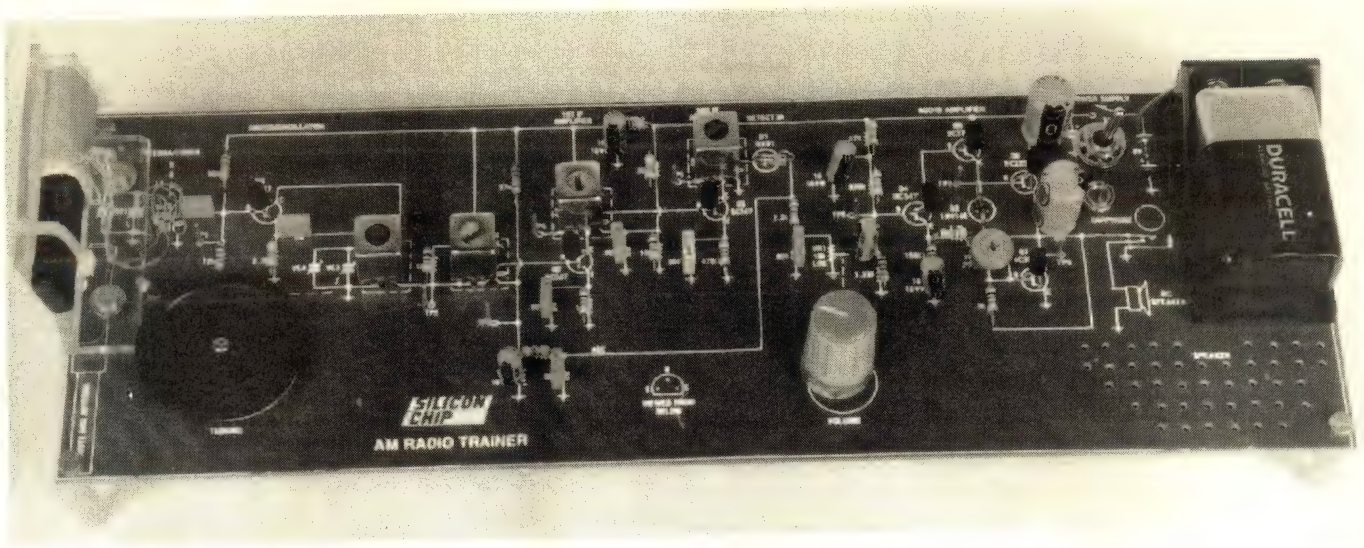


BUILD THIS AM RADIO TRAINER; PT.2

In this second & last article on the AM Radio Trainer, we show you how to assemble & align it for best performance. You won't need an RF signal generator for this task, as we describe a simple alignment oscillator at the end of this article.

By MARQUE CROZMAN & LEO SIMPSON

The big attraction of the AM Radio Trainer, apart from giving you the opportunity to build a classic circuit, is the fact that the PC board is overprinted with the circuit diagram. This is instead of the more usual component overlay diagram and should enable the novice to better come to grips with the functions of the various components.

There are also a number of test points on the circuit board and these can be used for voltage measurements or to provide waveforms which can be displayed on an oscilloscope. We will feature some typical waveforms in this article, so you will know what to expect.

Another point to note about the board is the large area of copper in the pattern. Most of this copper is all connected to the 0V rail from the battery and forms a "ground plane" for the circuit. This helps isolate the various sections of the circuit from each other and thereby ensures a good level of performance.

Before you start assembly of the board, there are a number of checks you should do. First of all, check that there are no shorts between tracks or breaks in tracks. These should be repaired before you go any further. Second, make sure that the board is suitably drilled for all the components. In particular, make sure that the IF transformers can be inserted and that there are holes drilled for the volume control potentiometer, for the mounting screws and shaft of the tuning gang, the 3.5mm headphone socket, the power switch and the battery holder.

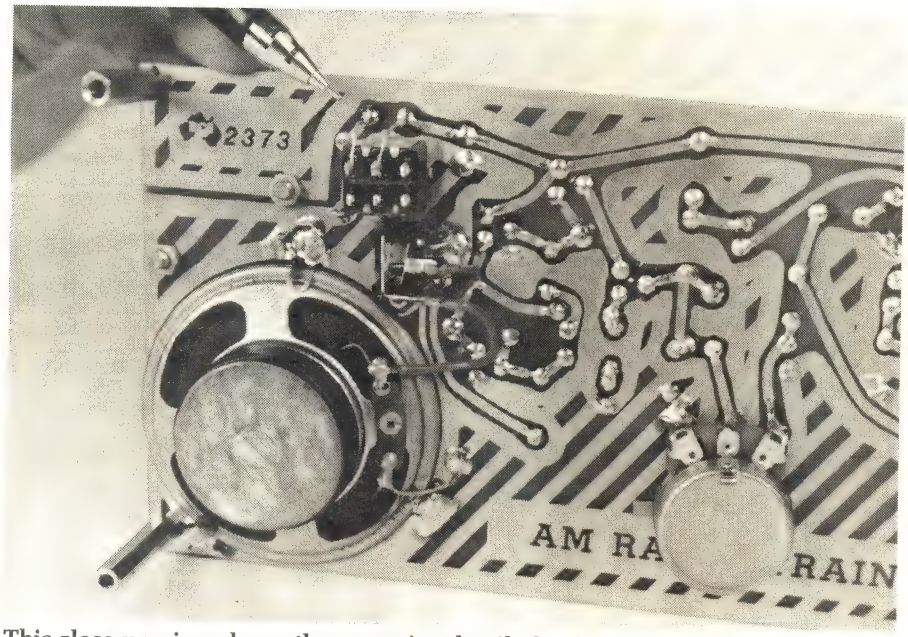
There should also be a pattern of small holes in the large circular region where the loudspeaker is to be mounted – otherwise the sound will be muffled.

The resistors should be inserted first. You can check the colour code for each resistor value by referring to the table of resistor values accompanying this article. However, whether or not you are familiar with the resistor colour code, we strongly suggest that you check each resistor value with a digital multimeter (switched to the appropriate "Ohms" ranges) before it is inserted and soldered into place.

The resistors can be inserted either way into the board but it is a good idea to install them so that their colour codes all run in the same direction. This makes it so much easier to check their values later on. Besides, it looks better.

Trimpot VR2 for the audio amplifier output biasing can also be installed at this stage. Note that its value should be 100Ω, not 200Ω as specified on the circuit last month.

Next, you can install all the capaci-



This close-up view shows the mounting details for the on/off switch, the headphone socket, the loudspeaker & the volume control. The loudspeaker is secured using three small solder lugs which are soldered to the groundplane.

tors with a value under 10µF, which means all the non-electrolytic capacitors. These are specified as monolithic or ceramic disc types.

In practice, you are most likely to be supplied with small rectangular capacitors which have leads 5mm apart, to match the hole spacing on the board. These will have their capacitance marked in one of two possible codes, EIA or IEC, as shown in the capacitor code table accompanying this article.

Having inserted the ceramic capacitors, the electrolytics are next. These have a black stripe down one side to indicate the negative lead. The electrolytic capacitors must be installed the correct way around otherwise they will be reverse-polarised and they will become leaky (in the electrical sense).

Next, install diodes D1 and D2. Don't swap them around otherwise the circuit won't work well at all. The OA91 germanium diode (D1) will have a larger glass body than the 1N4148 silicon diode (D2). Diodes are also polarised so be sure that the coloured band for the cathode is at the right end.

Note: on the circuit, the cathode end of the diode is the end to which the arrow is pointing. The arrow also indicates the direction in which current can flow. Normally, diode symbols on our circuits are marked with A and K to designate the anode and cathode.

Both diodes should be installed with a stress relief loop at one end so that they are less likely to be fractured if the board is stressed; ie, flexed or bent.

A trap for young players

The transistors go in next. Be sure to check that you get them around the right way. All the transistors specified come in plastic TO-92 encapsulation and the three leads from the underside are in a triangle configuration. This is shown on the pinout diagram on the circuit.

But there is a big trap for young (and old) players in assembling this board. Because we have printed the circuit on top of the board and arranged the circuit pattern to match it, it has been necessary to take liberties with the leads of most of the transistors. For Q1, Q2, Q3, Q4 and Q6, it is necessary to push the base lead between the emitter and collector leads, so that their leads match the circuit.

If you don't do this, the circuit won't work. And make sure you put the correct transistor in each position.

IF transformers

Now you can install the oscillator coil and IF transformers. These all look the same except for the colour of the slug at the top. The colours are as follows: oscillator coil (L2), red; 1st IF transformer (T1), yellow; 2nd IF transformer (T2), white; third IF transformer (T3), black (ie, no colour).

One point we did not cover in last month's circuit description concerns the capacitors which are connected in parallel with the primary winding of each of these transformers and the oscillator coil. Have a look now and note these capacitors. However, if you have a look on the PC board, you will find that there is no place to put the capacitors. That is because the capacitor for each unit is actually inside the can and is wired internally. So you don't have to worry about it.

Having capacitors inside the cans of resonant coils is common practice in radios, transceivers and TV sets. It ensures manufacturing consistency, minimises wiring and saves board space.

By the way, you should resist the temptation to twiddle the slugs of the IF transformers and oscillator coil by using a small screwdriver. Don't do it. You should buy a set of plastic alignment tools and use one which has a blade with a neat fit in the slot of the slug.

If you can't purchase a suitable alignment tool, you can make one out of a plastic styling comb. Cut off the long thin portion of the handle of the comb and then shape one end so that it is like a small screwdriver blade. You can easily do this with a sharp utility knife.

There are several reasons not to use a small screwdriver to adjust the slugs. First, it is all too easy to damage the slots in the slugs. Second, the blades of screwdrivers are often magnetised and this can affect the magnetic characteristics of the slugs. Third, when you are going through the actual alignment of the radio, the steel blade of the screwdriver will badly affect the resonance of the coil and you will get quite misleading results.

Ferrite rod antenna

When installing the ferrite rod antenna, you will need to solder the coil connections first and then secure the ferrite rod itself in place with a small plastic cable tie through the board. This is a temporary mounting method and there is a particular reason for doing it this way at this stage. The coil has four coloured cotton-covered wires and these should not be shortened back since they are already pretinned. The circuit board holes for the antenna connections are labelled with

Rear view of the assembled project. Bend the tags of the volume control & tuning capacitor so that they touch their respective pads on the board & solder them in place. The on/off switch, loudspeaker & headphone socket are connected to the PC board via wire links.

the colours; ie, white (WHT), black (BLK), red (RED) and green (GRN).

The plastic dielectric tuning capacitor is secured to the PC board by two small countersunk screws. After these are inserted and tightened, the three tags need to be bent at right angles to make contact with the relevant pads on the PC pattern; they are then soldered.

Secure the volume control potentiometer to the board with its washer and nut. Bend the tags so that they touch the pads on the board and solder them in place.

The battery holder and on/off switch are next to be mounted. The battery holder is mounted on the component side of the board and is held in place with two 8BA screws and nuts. Use short lengths of hook-up wire to connect its terminals to the relevant spots on the PC board. The on/off switch is mounted through the board and secured with a nut and washer. The terminals are then connected to the board with short lengths of wire.

Speaker mounting

Three small solder lugs hold the speaker in place, as shown in the photo. The lugs are soldered to the ground plane, equally spaced around the rim of the speaker.

Mount the headphone socket next to the on/off switch. The tab closest to the board is soldered to the ground plane. The other two connections must be made in such a way that when the headphone (or earphone) jack is inserted, it disconnects the speaker and connects the headphone. This means that the tag which makes contact with the tip of the jack when it is inserted must connect to the negative side of the 100µF 16VW capacitor. The other tag is connected to one side of the speaker. You can check the switching operation of the socket by using your multimeter.

The other terminal of the speaker is connected to the ground plane of the board via a short length of hook-up wire.

To finish off the construction, four 25mm tapped metal spacers are secured to the board with machine screws, one in each corner. This allows the board to sit on a flat surface and provides clearance for the volume pot, tuning gang and loudspeaker.

Now check all your work very carefully and you will be ready for the next stage which is alignment.

Aligning your radio

The major difference between this project and any other that you may assemble from the pages of this magazine is the need for alignment. Even if you have assembled the radio precisely as we have described so far, there is little chance that it will work satisfactorily when you first turn it on. This is because all the slugs in the IF transformers need to be adjusted to give the best gain.

At the same time, you will need to adjust the slug in the oscillator coil and the trimmer capacitors associated with the tuning gang to give the best "tracking". These latter adjustments ensure that the resonant circuit of the oscillator coil "tracks" with the input resonant circuit across the whole of the broadcast band. If this is not done, the sensitivity will vary quite markedly across the broadcast band.

Before you start the alignment process though, rotate trimpot VR2 fully anticlockwise. This will set the quiescent current in the output stage transistors, Q6 and Q7, to zero. Rotate the volume control pot fully anticlockwise and the tuning knob fully clockwise or anticlockwise. This done, connect a 9V battery or DC power supply set to 9V and then measure voltages around the circuit. Connect the negative probe of your multimeter to a point on the ground plane and then measure the following voltages:

Emitter of Q1	+0.95V
Emitter of Q2	+0.5V
Emitter of Q3	+1.1
Emitter of Q4	+4.7V
Base of Q7	+4.0V
TP8	+4.6V

In each case, the voltage should be within about ±10% of the value noted above. It will depend on the precise value of the supply voltage, the resistor tolerances and the individual gains of the transistors. If the voltages are quite different from the values listed above, then you should investigate why.

By the way, these voltages are "no signal" voltages, because little or no signal should be picked up by the input stage and the volume control is turned down so that there is no signal going through the amplifier stages. Naturally, the presence of signals will alter the voltages, *although* not greatly.

Note that if you take the trouble to calculate the expected base bias for each transistor and then subtract 0.65V to get the emitter voltage, you will find an odd result for the base bias voltage of Q2. This is because a major factor in its bias condition is the detector diode D1. This has a static forward voltage of 0.2V and this effectively "loads down" the voltage at the emitter to about 0.5V.

You can also measure the current drain now. This can be done by connecting your multimeter (switched to a low current range) across the on/off switch. If your multimeter has automatic polarity switching, you don't have to worry about how this connection is done. If your meter doesn't have auto polarity, connect the positive probe to the battery side of the switch and the negative probe to the other side. With the switch set to OFF, the current through the meter should be less than 10 milliamps. If the current is substantially more, you probably have a fault.

Note that there is a risk in this procedure of connecting your multimeter across the on/off switch. If one side of the multimeter shorts to the groundplane, you could damage your meter or, at the very least, blow its internal fuse.

A safer way of monitoring the current drain is to connect a 1Ω resistor in series with the positive lead to the battery holder. This done, use your multimeter to monitor the voltage across the resistor. For example, if the voltage reading is 9mV, (9 millivolts) then by Ohm's Law, the current will be 9mA (9 milliamps)

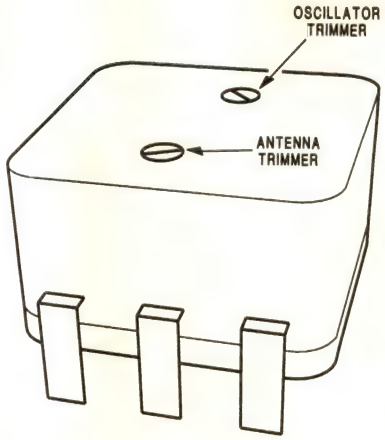


Fig.3: this diagram shows the locations of the antenna & oscillator trimmer adjustments on the tuning gang.

Aligning the IF stages requires the injection of a 455kHz signal into the front end of the circuit. Connect an RF oscillator, set to 455kHz, through a .001µF ceramic capacitor to test point TP1. If you build the test oscillator described later in this article, you will not need the .001µF capacitor. Ideally, you should disable the local oscillator by connecting a short lead between the collector of Q1 and test point TP2 but in practice, it doesn't seem to matter.

Connect your multimeter (set to read DC volts) between test point TP3 and ground. Set the generator to give an RF signal output of about 1mV. Now the idea is to adjust each of the slugs in the IF transformers in turn for a minimum voltage on test point TP3. What happens is that as you adjust the slugs, the gain of the IF stages improves and the signal fed to the detector diode (D1) increases. The detector diode rectifies the IF signal and so as the signal increases, the negative voltage produced by the detector increases. Hence, the voltage at test point TP3 decreases.

If you want to look at it another way, you will be adjusting the slugs for a null voltage at TP3. If you have an analog multimeter, you will find it more suitable for this task than a digital meter since you can judge the centre of the null more easily by the way the pointer swings back and forth as you tweak each slug.

Oscilloscope method

If you have access to an oscilloscope, you can connect it to TP5 and observe the IF signal directly. Now, as you adjust the slugs, you will see the

CAPACITOR CODES

Value	IEC Code	EIA Code
.022µF	22n	223
.01µF	10n	103
.0047µF	4n7	472

RESISTOR COLOUR CODE

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	1.2MΩ	brown red green brown	brown red black yellow brown
1	1MΩ	brown black green brown	brown black black yellow brown
1	820kΩ	grey red yellow brown	grey red black orange brown
1	56kΩ	green blue orange brown	green blue black red brown
1	47kΩ	yellow violet orange brown	yellow violet black red brown
1	39kΩ	orange white orange brown	orange white black red brown
1	27kΩ	red violet orange brown	red violet black red brown
1	12kΩ	brown red orange brown	brown red black red brown
1	10kΩ	brown black orange brown	brown black black red brown
1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
2	3.3kΩ	orange orange red brown	orange orange black brown brown
2	2.2kΩ	red red red brown	red red black brown brown
2	1kΩ	brown black red brown	brown black black brown brown
1	470Ω	yellow violet brown brown	yellow violet black black brown
2	100Ω	brown black brown brown	brown black black black brown

Setting the tuning range without an RF generator

In the accompanying procedure for setting oscillator and antenna tracking we assumed that you had access to an RF signal generator. For many constructors, this won't be the case and they will have to rely on broadcast signals at the top and bottom of the broadcast band.

However, this poses something of a "chicken & egg" situation. How do you do the tracking adjustments if you cannot receive the signals? In most cases, you should be able to readily receive a signal at or near the bottom of the broadcast band, especially at night. However, picking up a signal at the top end of the band might not be anywhere near as easy.

A solution to this problem is available if you have another AM radio. How's that again? Well, as you now know, every superhet radio has a local oscillator and for an AM broadcast receiver this oscillator will be 455kHz above the tuned frequency. Therefore, you can use the local oscillator in your other AM radio to set the tracking adjustments at the top of the band.

The method to follow is this: place the ferrite rod of the AM Radio Trainer near the antenna rod of your other AM radio (this will usually be at the top of the case). Rotate the tuning knob of the AM Radio Trainer fully clockwise to tune to the top of the band. Tune your other AM radio to 1165kHz or as close to this figure as you can.

As you do so, you should be able to hear a faint heterodyne whistle from the speaker of the AM radio. Now proceed to peak the antenna and oscillator circuits as described in the article.

signal increase or decrease. Adjust the slugs for the best possible signal amplitude. Note that if there is a tendency for clipping of the signal at TP5, just reduce the signal input from your RF oscillator.

Tracking adjustments

These adjustments ensure that the RF input circuit and the local oscillator cover the correct range of frequencies so that you can tune over the broadcast band. Ideally, you need an RF signal generator to do this task. If you don't have access to one, you will have to rely on tuning stations at the top and bottom of the band. In Australia, the broadcast band is specified as 531-1602kHz, so to be sure of covering this band, it is normal to make a radio tune slightly more, say 525-1620kHz.

Let's first proceed on the basis that you have an RF signal generator. Set it to 525kHz and rotate the tuning knob fully anticlockwise. This sets the plates of the tuning gang "in mesh" which is the maximum capacitance condition, for the low frequency end of the band. Now adjust the slug in the oscillator coil for maximum loudness of the signal via the speaker, or for maximum signal amplitude at TP5, if you have an oscilloscope.

Now rotate the tuning knob so that it is fully clockwise. Set your RF signal generator to 1620kHz. Tune the adjustment screw on the back of the tuning gang labelled "oscillator trimmer" (see Fig.3) for maximum signal amplitude, as before.

Rotate the tuning knob fully anticlockwise and redo the oscillator coil slug adjustment again at 525kHz. This done, go back to the top of the band at 1620kHz and adjust the oscillator trimmer again. These adjustments need to be done a number of times as the top adjustment affects the bottom adjustment and vice versa.

You have now adjusted the oscillator range so that the broadcast band can be tuned in. As a point of interest, the oscillator will now be tuned over the range 980-2075kHz.

Now you need to adjust the ferrite rod coil and antenna trimmer (on the back of the tuning gang). Set the tuning knob fully anticlockwise and set the RF signal generator to 525kHz, then move the coil along on the ferrite rod until the signal amplitude is at a peak. Now set the RF generator to 1620kHz and turn the adjustment screw on the back of the tuning gang labelled "antenna trimmer" (see Fig.3) until you peak the incoming signal again.

You should now repeat these adjustments for the optimum response. When this is done, the ferrite rod coil should be fixed in place by melting a little candle wax over one end.

That completes the alignment of the AM Radio Trainer.

Quiescent current

All that remains to be done is to set the quiescent current by means of trimpot VR2. By selecting a value of 100Ω

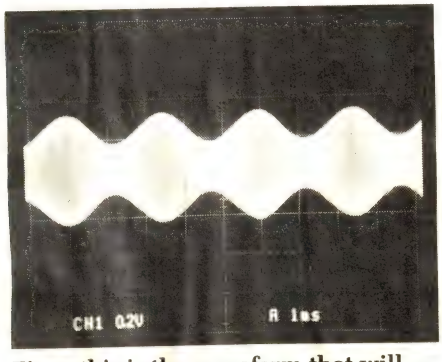


Fig.4: this is the waveform that will appear at test point TP5 during alignment if you are using a signal generator modulated at 400Hz.

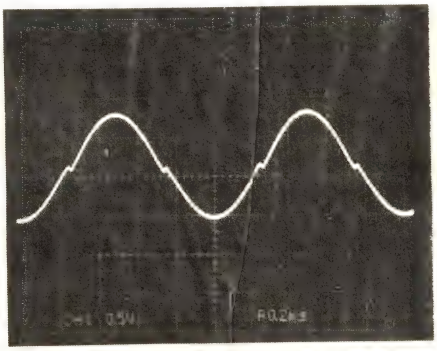


Fig.5: this 1kHz sinewave shows the crossover distortion nicks which will be present when the quiescent current in the audio output stage is zero.

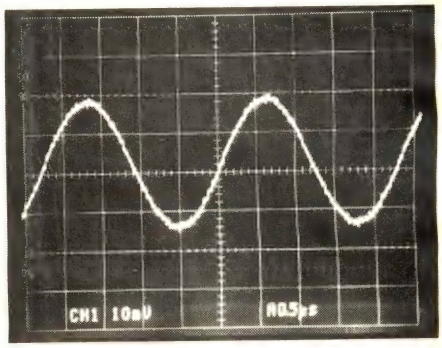


Fig.6: this is the waveform from the calibration oscillator shown in Fig.7. The hash on the waveform is the residual 3.58MHz harmonic content.

A Crystal Controlled IF Generator

If you can't lay your hands on an RF signal generator to do the alignment for your AM Radio Trainer, then you can build this crystal controlled IF generator board. It is based on a standard American 3.579545MHz colour burst crystal. When divided by 8, you end up with a frequency of 447.4kHz. This is within 2% of 455kHz and is probably more accurate than you would obtain by setting a typical RF generator to 455kHz.

Three CMOS gates of a 4011 quad gate package are connected in series and the 3.58MHz crystal connected between input and output via a 1.5kΩ resistor. The gates are biased into the linear region with the 4.7MΩ resistor and the output is a square wave. This is buffered by the fourth gate of the 4011 which then drives IC2, a 4040 12-stage binary counter. The divide-by-8 pin of the 4040 is then used as the output.

A third order low-pass RC filter then removes the harmonics and reduces the amplitude to a level suitable for injecting into the IF strip. The final output is a sinewave with an amplitude of about 35mV peak-to-peak into a 10kΩ load.

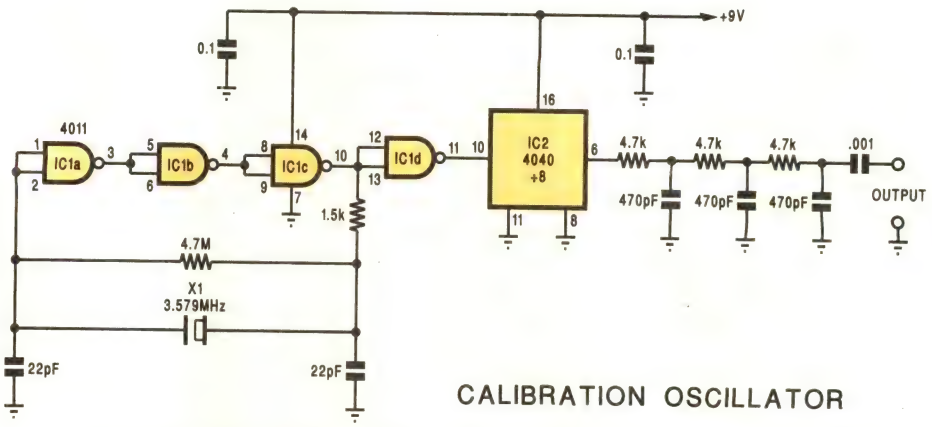


Fig.7: the circuit divides the output from a 3.58MHz crystal oscillator by eight & then filters it to provide a sinewave at 447.4kHz.

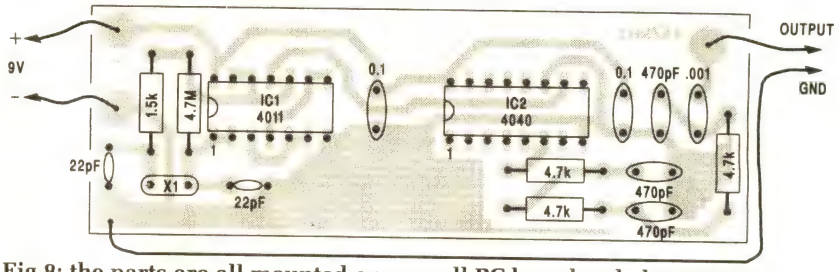


Fig.8: the parts are all mounted on a small PC board coded 06107931.

Construction

Check the board carefully for shorts and breaks in the tracks. This done, install the resistors first, followed by the capacitors and ICs.

Next mount the crystal and the PC stakes. Lastly, the battery clip leads can be soldered in.

In operation, this oscillator needs to run from a fresh 9V battery, as it drops in frequency below about 8.5V or so.

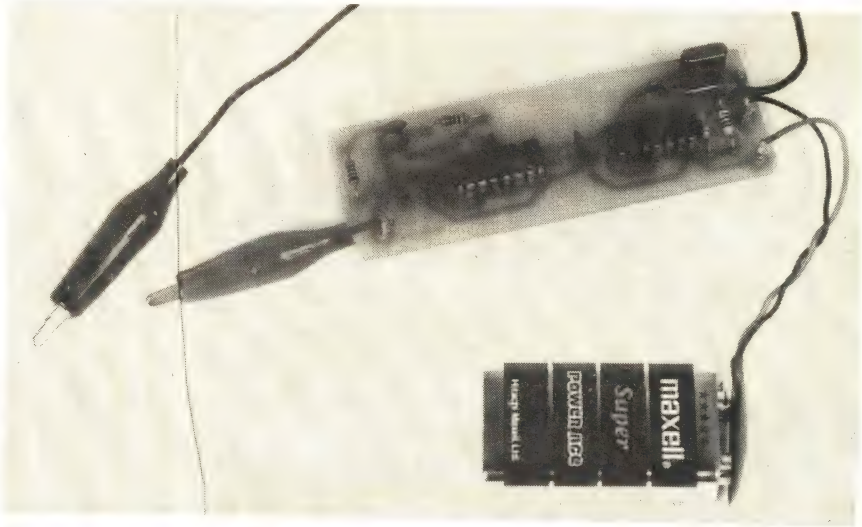
PARTS LIST

1 PC board, code 06107931, 88 x 30mm
1 9V battery clip
1 9V alkaline battery
2 alligator clips

Semiconductors
1 4011 quad 2-input NAND gate (IC1)
1 4040 12-stage binary ripple counter (IC2)

Capacitors
2 0.1μF 63VW metallised polyesters
1 .001μF ceramic
3 470pF ceramic
2 22pF ceramic

Resistors (0.25W, 1%)
1 4.7MΩ
1 1.5kΩ
3 4.7kΩ



This view shows the fully-assembled alignment oscillator. Note that it should be powered from a fresh 9V battery, as it drops in frequency below about 8.5V. Connections to the AM radio are made via alligator clips.

The sensitivity of the receiver can be improved by mounting the ferrite rod up off the board using a plastic bracket. The reason for doing this is that the copper pattern on the board substantially de-sensitises the antenna.

Acknowledgement: our thanks to Bob Barnes of RCS Radio Pty Ltd for producing the prototype screen printed boards. RCS Radio can supply the board in two versions: a standard phenolic board with the circuit screen-printed in black on the topside, or the deluxe board which is screen printed in two colours (white circuit on a deep blue background). The code number is 06106931. The standard board is available for $19.90 and the deluxe board is $24.90. Post & packing is $2.00. Contact RCS Radio Pty Ltd, at 651 Forest Road, Bexley, NSW 2207. Phone (02) 587 3491.

for this trimpot, we have deliberately restricted the range of adjustment. This has been done for safety's sake because if the range of adjustment was larger, it would be possible to destroy one or both of the output transistors, because of excessive quiescent current.

The best way to adjust the quiescent current is to feed a sinewave modulated signal into the front end of the radio from an RF signal generator. Connect an oscilloscope to the output at test point TP8 and adjust the volume control for a signal amplitude across the speaker of about 2V or 3V peak to peak. At this stage, VR2 should still be fully anticlockwise

If you now have a look at the signal on the scope screen, you will see the classic sinewave with crossover distortion – notches in the waveform at the crossover point (see Fig.5). Now if you rotate VR2 you will see the crossover nicks disappear from the waveform and, at the same time, the sound will become cleaner. Rotating VR2 to reduce the crossover distortion will not increase the current by much, by no more than a milliamp, but it will make a big difference to the sound quality.

By the way, you should measure the current drain of the radio while you are adjusting the quiescent current with trimpot VR2.

Typically, the current drain of the radio at 9V should be less than 10 milliamps when the volume control is at minimum setting (ie, no signal through the audio amplifier stages). With the volume control well advanced to make the radio quite loud, the current drain may be 40 milliamps or more.

You can also easily measure the current drain of the radio without the audio stage. Just plug an open-circuit 3.5mm jack into the headphone socket. This disconnects the loudspeaker and causes the amplifier to latch up and thus draw negligible current. Under these conditions, the rest of the radio circuit will draw around 4mA or less.

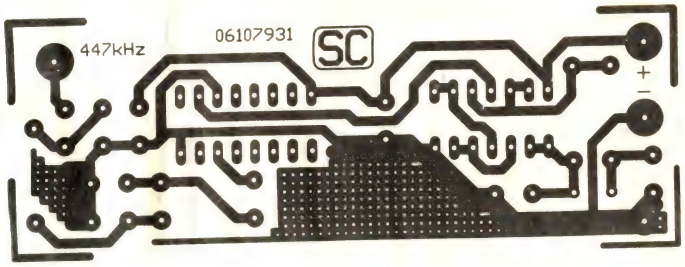


Fig.9: this is the full-size PC pattern for the calibration oscillator.

Mounting the ferrite rod

By now, you will have tried out the radio and possibly found that its performance leaves something to be desired, even though you should be able to tune in stations right across the broadcast band. You will find lots more stations at night, provided you are not attempting to listen to your radio close to a TV set or computer. Both cause loud whistles across the dial.

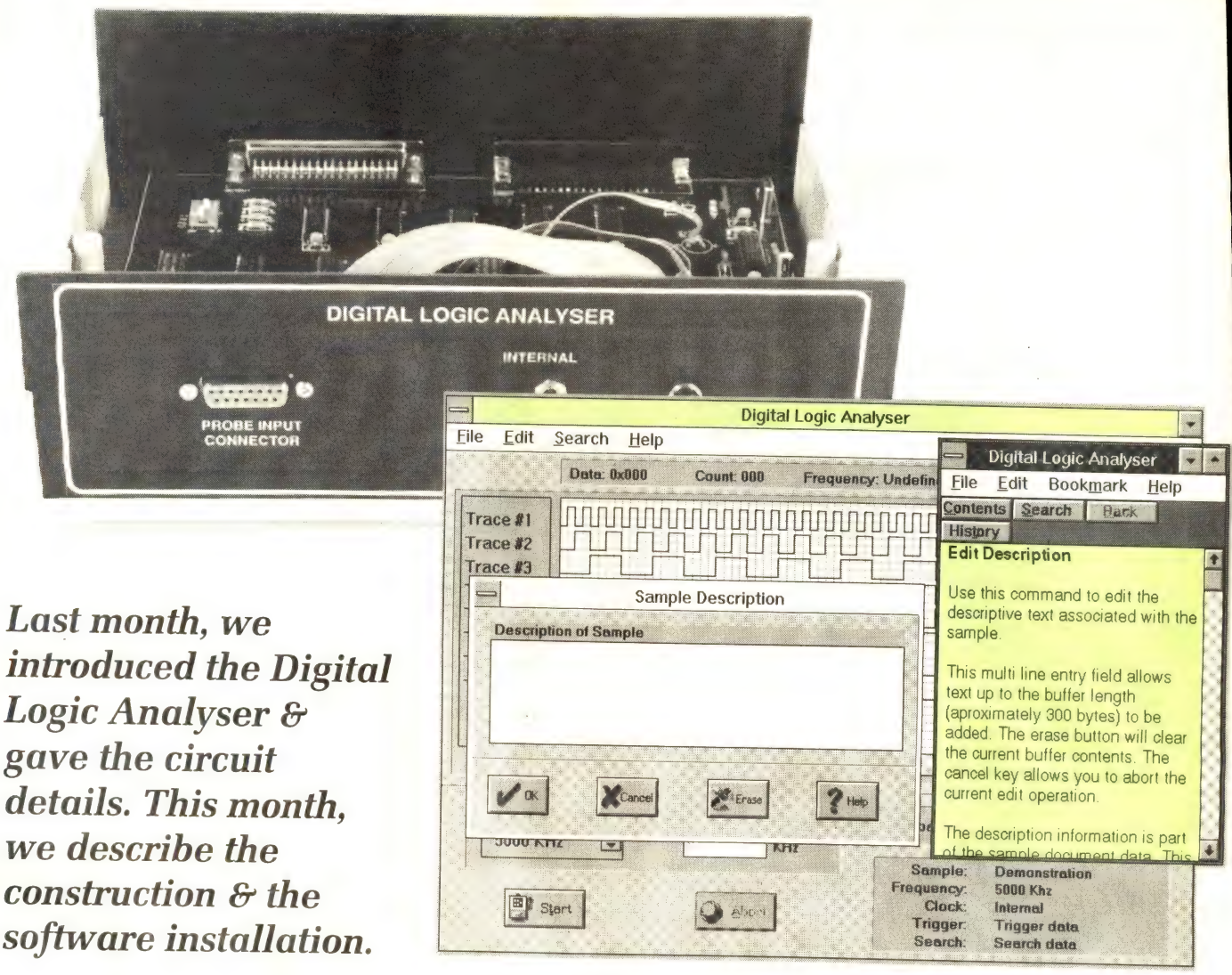
There is a further step you should take to get the best out of your radio and that is to mount the ferrite rod antenna up off the board by at about 25mm. The reason for doing this is that the copper pattern of the PC board substantially de-sensitises the antenna – in fact, any metal will do this.

To mount the antenna rod off the board by the requisite amount, we made up a rightangle bracket out of scrap plastic. This was secured to the PC board with two screws and nuts, while the rod was secured to the bracket with two small plastic cable ties.

Mounting the antenna rod in this way will make a substantial difference to the sensitivity. You should repeat the peaking procedure for the ferrite rod coil and antenna trimmer.

Notes & Errata

The trimpot specified for VR2 in the audio amplifier output stage should be 100Ω, not 200Ω as specified in the first article. **SC**



Last month, we introduced the Digital Logic Analyser & gave the circuit details. This month, we describe the construction & the software installation.

Windows-based digital logic analyser; Pt.2

By JUSSI JUMPPANEN

Despite the apparent circuit complexity, this project is very easy to build. All the circuitry is contained on the two double-sided PC boards and these feature plated-through holes, component overlays and solder masks. The main thing to watch out for is that all parts are correctly installed the first time. Once you have soldered a part into a plated-through board, it is quite difficult to remove.

The easier of the two boards is the internal XT bus card which uses just five ICs plus a few other parts. None of these ICs require sockets so the first step in the construction is to solder them all in place. Make sure that each IC is correctly positioned and that it is aligned as shown in the overlay diagram – see Fig.7.

Once the ICs have been soldered into place, the 8-bit DIP switch, resistors and decoupling capacitors can be added. Finally, the female DB37 connector can be soldered into place and the slot bracket attached to the card – see photo in Pt.1.

Make sure that the DB37 connector used is a female type and that it is a long version so that it protrudes the correct amount beyond the end of the board. If a short DB37 connector is used, the socket will not be flush with

the PC case when the card is installed in the bus slot.

Logic analyser board

The external logic analyser card is a little more complicated to build as it uses some 29 ICs in total. The first step is to install IC sockets for IC1, IC2, IC10, IC13 & IC22 – see Fig.9. Do not use sockets for the remaining ICs however, as they will only add to the expense of the project.

Once the sockets have been installed, the remaining ICs can be installed by soldering them directly to the PC board. As before, take care to ensure that each IC is placed in its correct location and is oriented correctly. This done, the remaining components can be installed. These include the resistors, capacitors and crystal. A 16-pin IDC socket will also have to be soldered into the IDC16 location.

A point to note here is that although the PLL (IC13) is a 74HC4046, not all 74HC4046s are the same. A Philips device will be supplied with the kit but a National Semiconductor device can also be made to work simply by changing a few component values – see Table 4.

At this point, the DB37 expansion port connectors can be added. A male connector is used for the input socket, while a female connector is used as the output socket.

The final stage in the construction involves the wiring of the channel inputs and the external clock. The channel inputs are very simple to wire because IDC connectors are used. The external clock wiring (to the input socket and switch) is slightly more difficult because each lead has to be soldered independently, but fortunately there are only six connections to make.

The external board can now be mounted in the instrument case. To do this, the front and rear panels need to be drilled to match the supplied templates. The rear panel is then fastened to the DB37 connectors, while the DB15 channel input connector, external clock input RCA jack and internal/external clock switch are attached to the front panel.

All that remains now is to wire the nine probe clips (eight input channels plus ground) to the matching DB15 plug connector. Be sure to connect each input to the pin number designated on the circuit diagram and use a black probe clip for the ground connection.

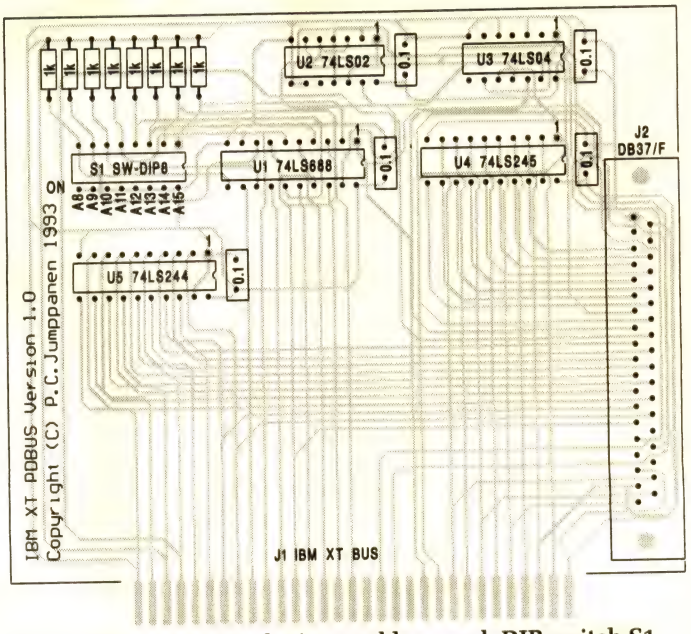


Fig.7: parts layout for the internal bus card. DIP switch S1 (top, left) is used to partially set the hardware address.

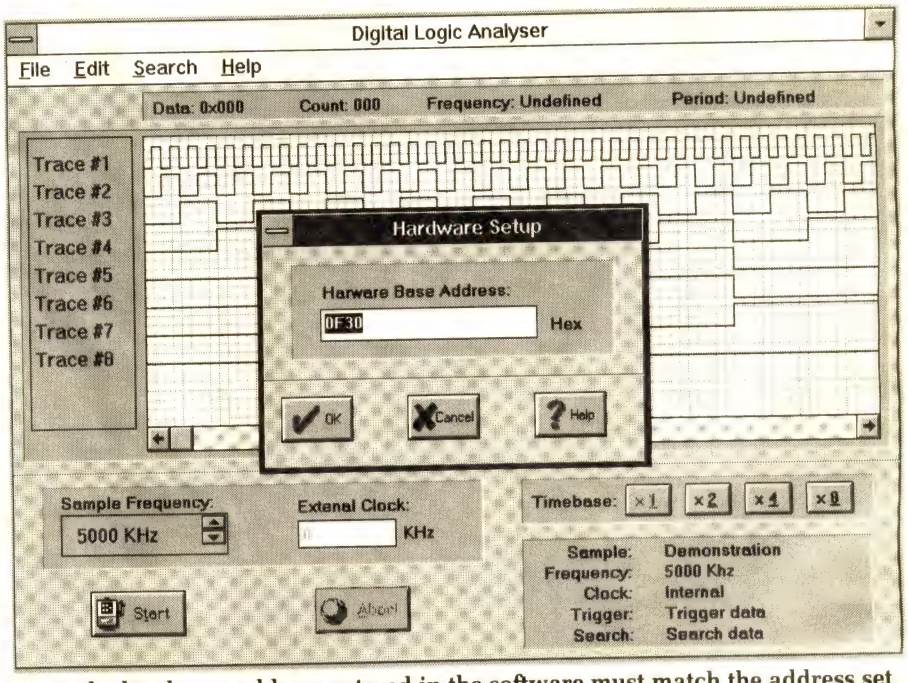


Fig.8: the hardware address entered in the software must match the address set by the DIP switches on the internal & external cards – just click Edit/Hardware to bring up the above display. The default is 0F30; change this only if necessary.

Hardware installation

The first step in the installation is to set the DIP switches on the two PC boards to match the required I/O address. During testing, the I/O location 0F30 was used successfully on a machine with two serial ports, a printer port, a games port and a fax card. It is recommended that this location be used for your initial tests.

Table 5 shows the DIP switch settings on the two boards for various I/O addresses. **Note that, because of the inverting nature of the circuit, a logic 0 is set by turning the DIP switch on, while a logic 1 is set by turning the DIP switch off.**

Thus, to set an address of 0F30, turn DIP switches A15-A12 ON and A11-A8 OFF on the internal card; and

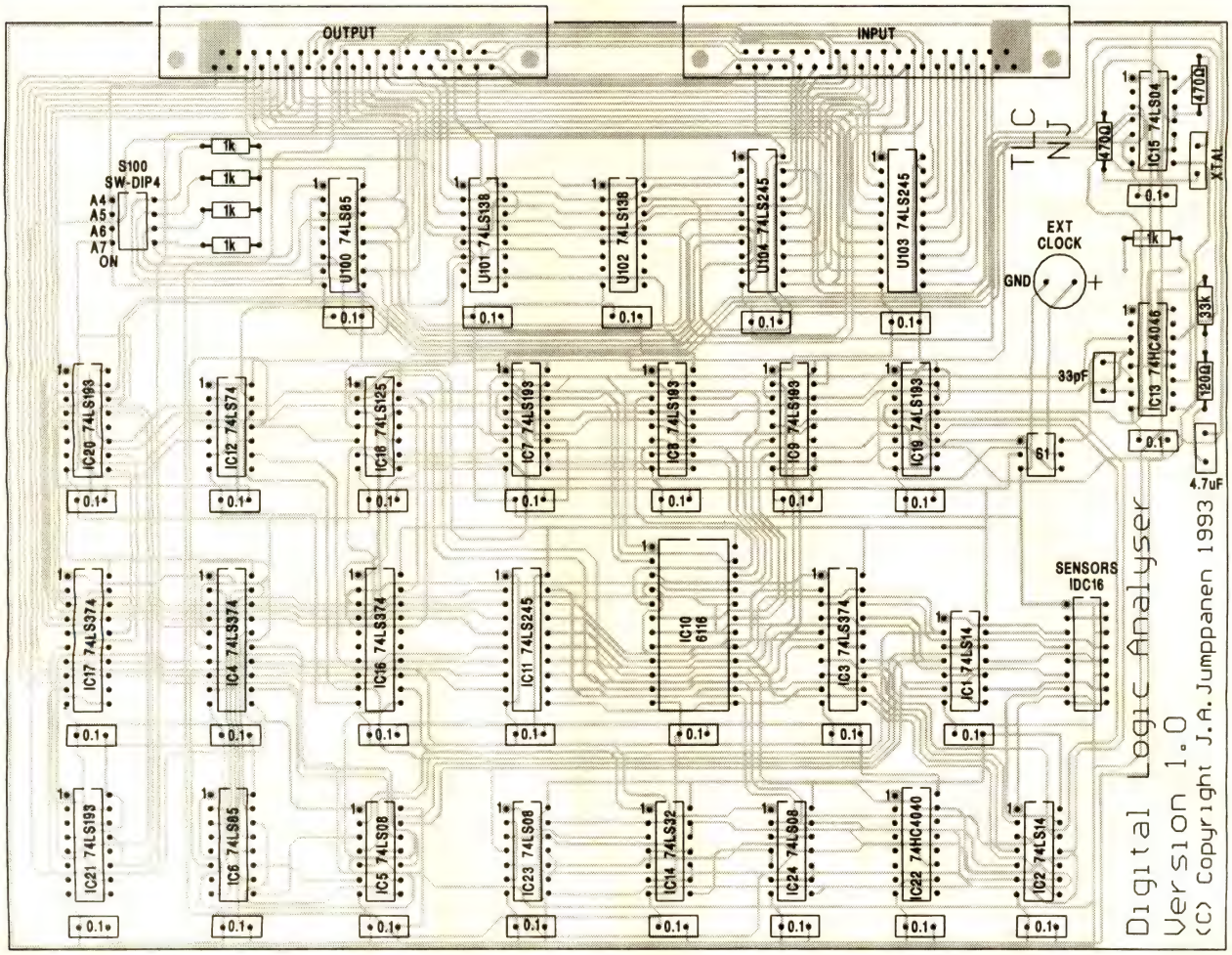


Fig.9: parts layout for the external PC board. Install IC sockets for IC1, IC2, IC10, IC13 & IC22 but not for the other ICs. A male DB-37 connector is used for the input socket, while a female connector is used for the output socket.

turn A7-A6 ON and A5-A4 OFF on the external card. The remaining address locations (A3-A0) are fixed – see Table 5.

The internal card can be inserted into any spare XT or AT bus slot (make sure that the power is off). At this point, the computer can be powered up and checked to ensure that it boots as normal. If the machine starts but locks up, the card is probably using an I/O location required by another device. If so, turn the machine off, change the I/O address to another location (eg, to 1030, 0E30 or 0D30) and try again.

Software installation

An installation program on the disc supplied with the kit makes this job a breeze. This program must be run from within Windows.

To install the software, insert the disc into drive A:, then choose the FILE RUN menu option and type A:\install. This will install the software into a directory called **dla** (you have the option of changing this to another name) and create the relevant program group. After that, the program can be run by double clicking

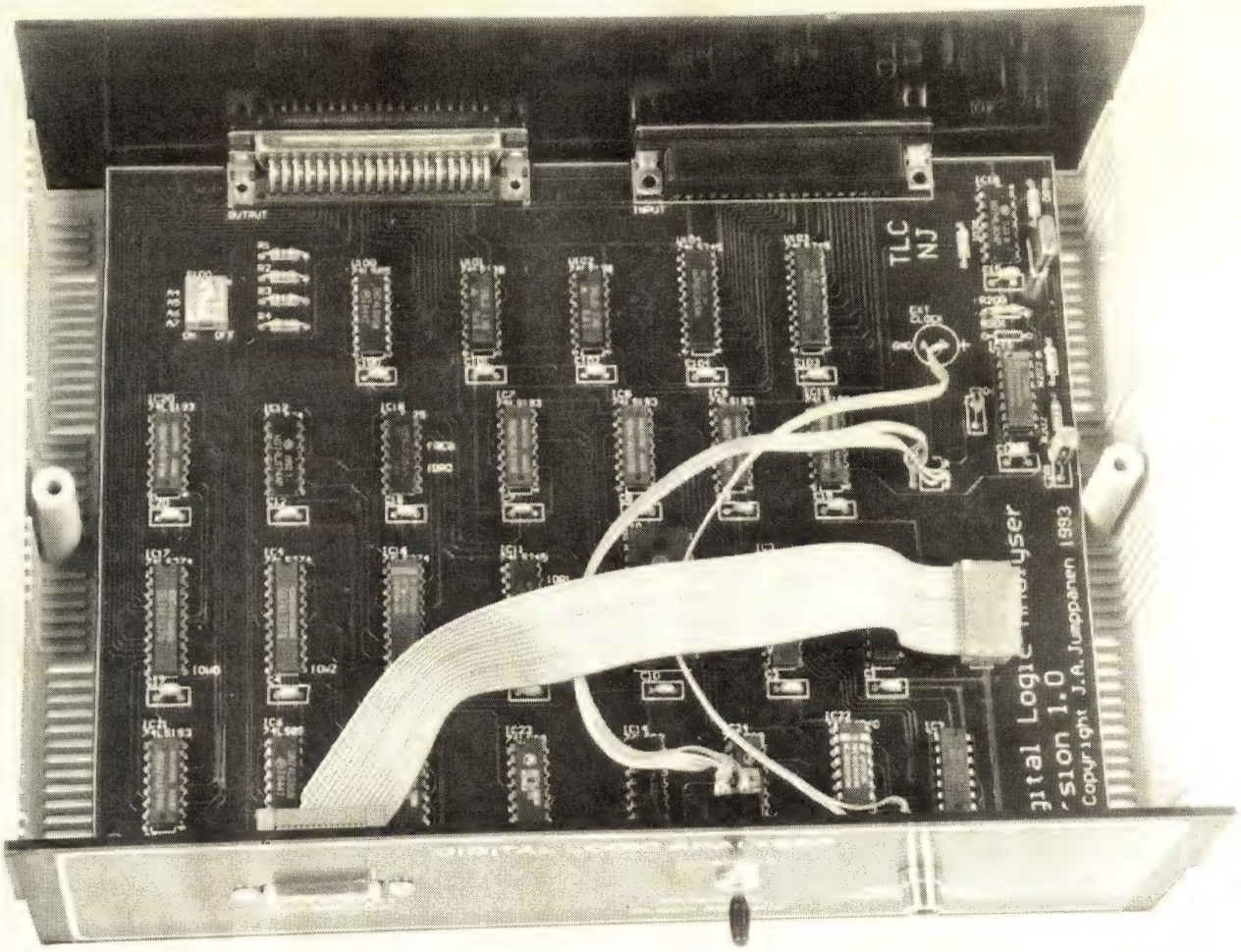
TABLE 4

IC13	Philips 74HC/HCT4046	NS 74HC4046
C200	2200pF	33pF
C201	0.47uF	4.7uF
R200	10k	1k
R202	100 ohms	120 ohm
R203	10k	33k

TABLE 5

	Internal XT Card								External Card				Fixed			
Address	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
1030H	0	0	0	1	0	0	0	0	0	0	1	1	0	x	x	x
0F30H	0	0	0	0	1	1	1	1	0	0	1	1	0	x	x	x
0E30H	0	0	0	0	1	1	1	0	0	0	1	1	0	x	x	x
0D30H	0	0	0	0	1	1	0	1	0	0	1	1	0	x	x	x

Note 1: 0 = DIP Switch ON; 1 = DIP Switch OFF due to the inverting nature of the circuitry.
Note 2: an "x" means software controlled addressing.



Above: the IDC socket on the external board is wired to a DB15/F connector on the front panel via a ribbon cable. The front panel also carries the DPDT clock source switch & an RCA socket for the external clock input.

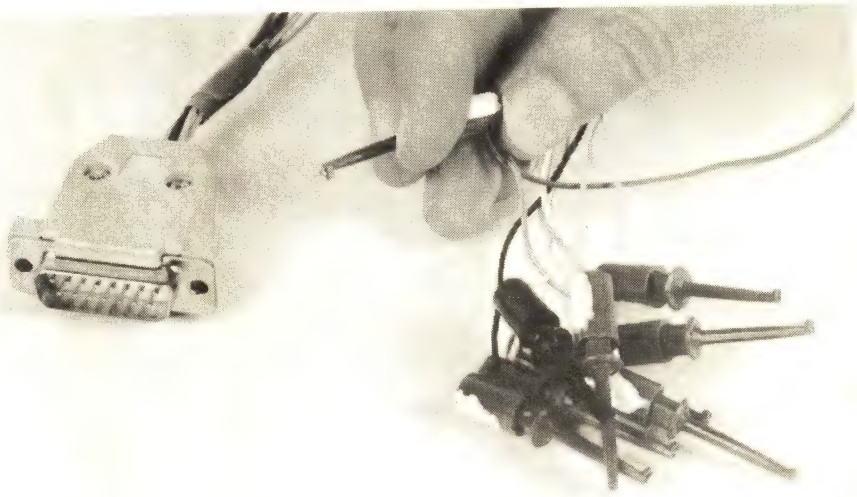
on the Digital Logic Analyser icon.

With the software running, click the Edit/Hardware menu option to set the hardware address to match the address previously set by the DIP switches (the default is 0F30; change this only if necessary). The hardware addressing can then be easily checked by toggling the external/internal clock switch on the front panel.

As the switch is toggled, the clock status field at the bottom right of the screen should also toggle to match the switch setting. If the status does not change, this probably means that the actual hardware address does not match the software hardware address.

If this fails to fix the problem, check the switch wiring. The voltage on pin 9 of IC18 should change from 0V to 5V as the switch is toggled. If no voltage change is observed it means that the switch is wired incorrectly. If the voltage changes but is not registered by the software, the address must be wrong.

When the internal/external clock is correctly registered by the software, the system is correctly configured and the setting will not need to be changed again. The project can now be tested for correct operation by first connecting the various channel probes to any suitable TTL clock circuit (don't forget to connect the ground probe). Fig.12 shows a suitable test circuit.



The nine probe clips (eight input channels plus ground) are wired to a DB15 plug connector that matches the socket on the front panel. Be sure to connect each input to the pin number designated on the circuit diagram.

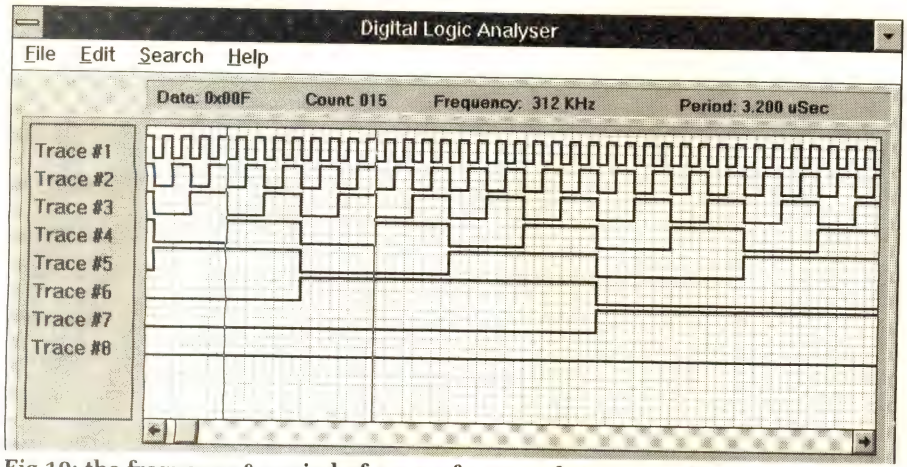


Fig.10: the frequency & period of a waveform can be measured by clicking the right mouse button at the start of a cycle & by holding down the SHIFT key & clicking the right mouse button at the end of the cycle.

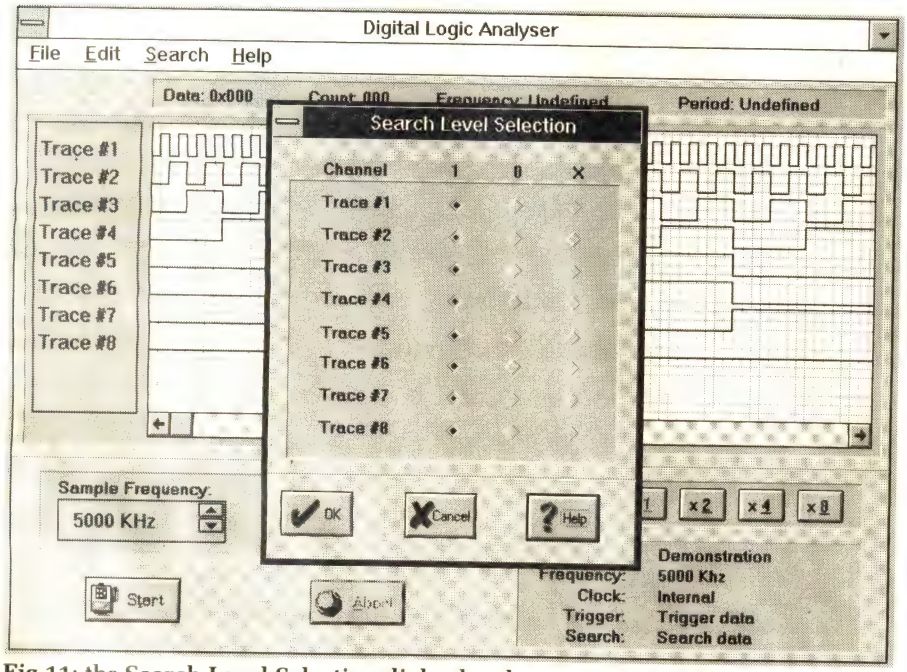


Fig.11: the Search Level Selection dialog box lets you search for particular data samples & trigger levels. A channel can be marked high, low or don't care. All individual channel search criteria must be met for the search to succeed.

The next step is to program the triggering options and the sample frequency. To program the triggering options, simply select the Edit/Trigger menu to bring up the Trigger Selection menu (or double click the left mouse button in the display area). The sample frequency can be set anywhere between 100kHz and 6MHz (in 100kHz steps) by clicking on the UP & DOWN buttons located towards the bottom left of the display.

After that, it's simply a matter of clicking on the Start button. If the sample is not completed within one second, click on the Abort button, reprogram the trigger value and try again. If all is OK, the screen should refresh and the results of the sample will be displayed.

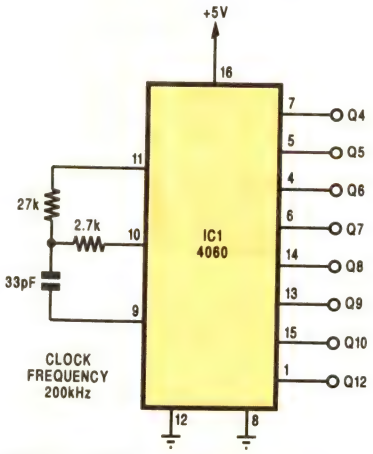


Fig.12: this simple test circuit generates eight spot frequencies ranging from 12.5kHz to 48.8kHz.

A context-sensitive help system is provided and this can be accessed at any time by clicking on the Help menu option. For example, if the Help button is clicked in the Trigger selection menu, an explanation of the Edit Trigger Command will be given.

Once you have sample waveforms displayed, you can try out some of the other features of the software. For example, you can examine the effects of changing the trigger selections and the timebase option. The software also lets you search for particular data samples and trigger levels. And if you don't like the display colours or the line thickness, you can edit these to suit your requirements.

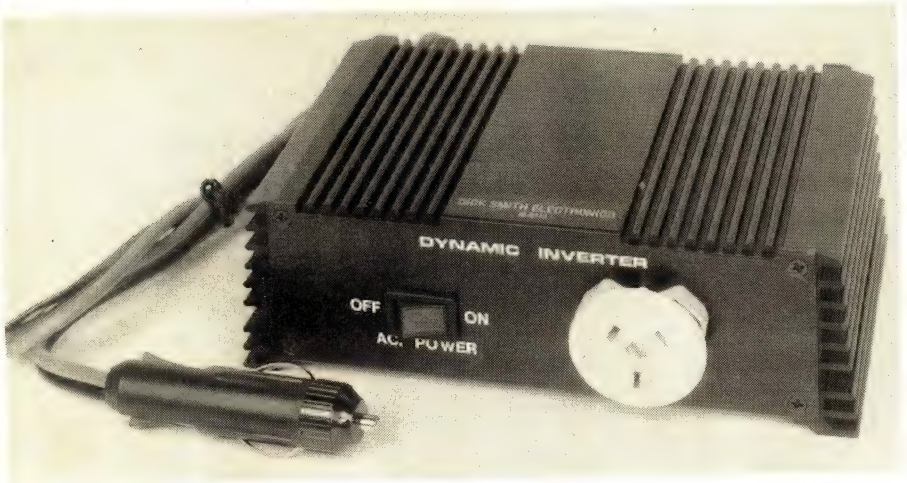
You can also make accurate frequency and period measurements on individual waveforms. To do this, place the cursor at the beginning of a waveform cycle and click the right mouse button, then move the cursor to the end of the cycle and click the right mouse button while holding down the SHIFT key. The frequency and period of the waveform can now be read from the data bar.

Finally, readers should note that the 4MHz crystal was left off the main circuit diagram (Fig.4). This crystal goes between pin 13 of IC15f & pin 10 of IC15e. Several pin numbers were also left off: the input of IC15d is pin 9; the input of IC15e is pin 11; and the input of IC15f is pin 13. **SC**

Where to buy the kit

The kit is offered in three formats:
(1). A complete kit consisting of all the parts as listed – price $215.00 plus $10.00 p&p.
(2). A complete kit of all parts except for the case – price $185.00 plus $5.00 p&p.
(3). Two double-sided PC boards (with screened overlays) plus software – price $90.00 plus $5.00 p&p.
To order, send cheque or money order to Jussi Jumppanen, PO Box 697, Lane Cove 2066, NSW. Phone (02) 428 3927. Please specify whether a 5¼-inch or 3½-inch disc is required.
Note: copyright of the two PC boards for this project is retained by the author.

PRODUCT SHOWCASE



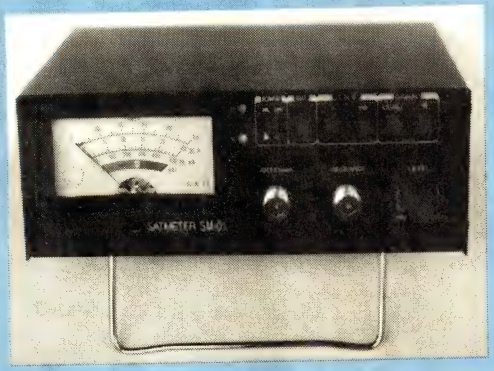
12VDC to 240VAC inverter

This compact 12V to 240VAC inverter will operate most low powered electrical equipment such as VCRs, TV sets, fans, computers, small kitchen appliances and in fact, almost any mains-powered appliance with a power consumption of up to 160 watts.

No-load power consumption is a mere 1.2W while the output surge capability is 400W. Weight is 1.1kg and dimensions are 180 x 105 x 60mm.

The inverter is available from all Dick Smith Electronics stores at $249 (Cat. M-5010). Also available is a 600 watt model at $399 (Cat. M-5000).

Dynalink dish alignment meter



This dish alignment meter covers the frequency range from 900-2050MHz and it contains a nicad battery pack, allowing the LNB (low noise block) of the dish to be powered directly. The instrument has a 2-stage MMIC (monolithic microwave IC) amplifier and internal integrator to average all signals in the LNB output band and then drive an analog signal strength meter. It has an adjustable sensitivity control and an audio indicator which increases in pitch as the dish alignment is improved.

For anyone contemplating dish installations for either the present or future pay TV transmissions, this is an indispensable tool. The unit comes complete with a 2-metre length of RG-6/U cable with F connectors, wall charger and carry case with shoulder strap. The meter can be looped into the coax feed from a satellite receiver to verify LNB power consumption and polarity.

The Dynalink SM-01 Satmeter is available now for $470.

For further information on this product and other satellite TV products, contact Av-Comm Pty Ltd, PO Box 225, Balgowlah, NSW 2093. Phone (02) 949 7417 or fax (02) 949 7095.

Panasonic GPS receiver

Panasonic's KX-G5500 GPS receiver is a compact receiver which measures a mere 130 x 65 x 35mm and offers all the benefits of portability and easy operation. It's powered by a long-lasting, rechargeable nickel metal hydride battery or from a AA alkaline battery pack (supplied). A lithium battery serves as a memory backup.

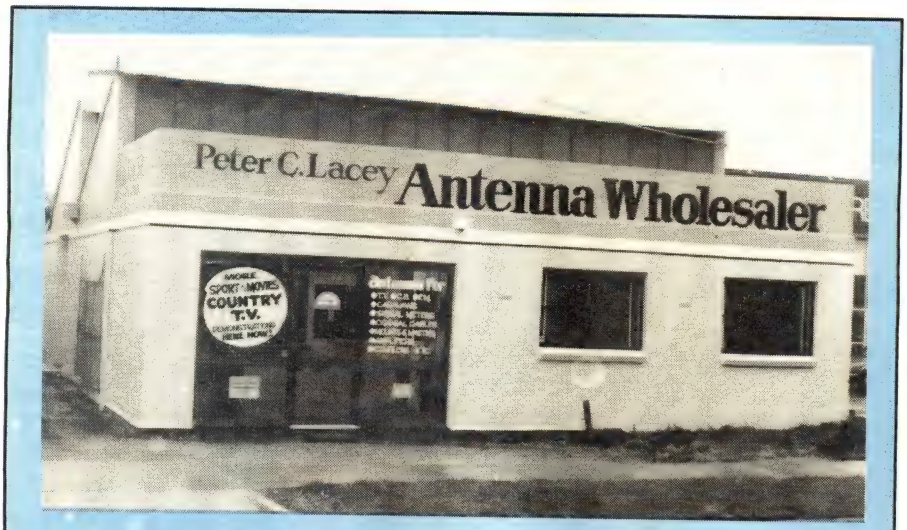
The KX-G5500 comes complete with external antenna, antenna/DC adaptor, adjustable mount, carry case, battery charger and AC adaptor, and alkaline battery case. The case is splash resistant and features a backlit LCD panel so that it can be read in the dark.

Note: all GPS receivers are subject to a degradation of position of plus or minus 100 metres as determined by the US Department of Defence.

For further information, contact Panasonic Australia by phoning (02) 986 7400.

Rack mounted personal computers

Modgraph Inc, well known as a manufacturer of Super-VGA colour monitors, now offers a range of personal computers in a series of rack-mounted configurations. Intended for applications where high resolution



Peter Lacey has moved

Peter Lacey has moved his wholesale antenna and instrument supply business to larger premises in Frankston. According to Peter, the company "experienced incredible growth through the aggregation boom of last year. With a number of new product opportunities in front of us, we decided that the cost of extra space was a small price to pay to improve service. Some unique antenna products combined with our installation background means we can help technicians achieve better results from their antenna work".

The new address for Peter C. Lacey Services Pty Ltd is 80 Dandenong Rd, Frankston, Vic 3199. Phone (03) 783 2388 or fax (03) 783 5767.

colour and PC processing capabilities are needed in a standard 19-inch rack format, the GX-4500 offers 800 x 600 resolution.

The GX-4500's Sony Triniton-based super VGA 8.5-inch diagonal, flat screen display is mounted with the disc drives alongside. There is a choice of 286, 386 or 486 processors, with two to five expansion slots and internal hard disc drives up to 200 megabytes. In keeping with the rack mount configuration, the system's 89-key keyboard can be mounted on a slide which goes under the PC, or can be folded over the screen and disc drives.

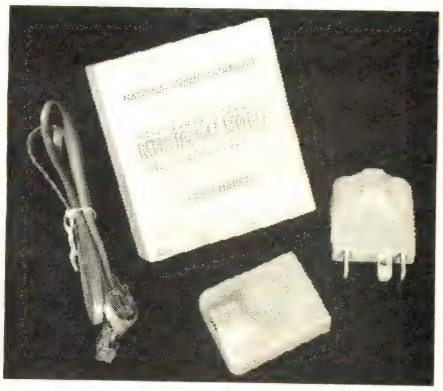
For further information, contact Amtex Electronics, 13 Avon Rd, North Ryde 2113. Phone (02) 805 0844.

8-channel relay board

The AX5008 relay and isolated digital input board plugs directly into any expansion slot of an IBM PC/XT, AT or better. The eight SPDT relays are intended for low power switching; their contacts are rated at 3A at 120VAC or 24VDC with a resistive load.

The eight opto-isolated digital inputs provide 1kV channel to channel or channel to ground isolation. Their input impedance is 800Ω. Connections are made via a 37-way D-type male connector which is supplied with the board. For more information, contact Boston Technology Pty Ltd, PO Box 1750, North Sydney 2059. Phone (02) 955 4765.

Music on hold for phones

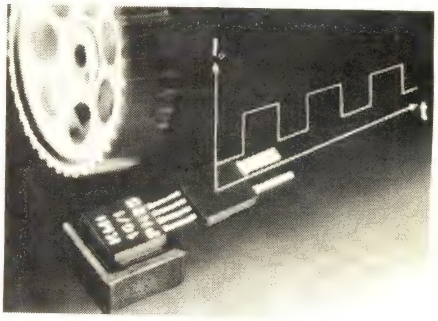


This Austel approved device allows any phone system to provide music on hold for incoming callers or outgoing callers. To place a call on hold you merely press 8 on a tone or pulse dial phone. To pick up the call again, press 8 again. The music program may be from any source such as a tape player or radio.

The device itself uses US modular phone plugs and sockets but Telecom adaptor plugs are also supplied. The Music-On-Hold adaptor is priced at $279 while an Austel approved line isolation transformer is an extra $80.

For further information contact David Reid Electronics, 127 York St, Sydney, NSW 2000. Phone (02) 267 1385.

Rotational speed sensor



The Philips KMI10/1 rotational speed sensor is claimed to be the first fully integrated contactless speed sensor to meet all the requirements of the automotive industry. Features include accurate measurement down to zero rpm, an ability to operate at tooth-to-sensor spacings as large as 2.5mm and at ambient temperatures as high as 190°C. These sensors operate with a wide variety of wheel teeth struc-

res while a built-in hysteresis in the gnal conditioning circuit makes it mmune to vibrations.

This combination of features suits he KMI10/1 for use in automotive pplications such as ABS (Anti-lock rake Systems), ASC (Anti Slip Con-ol) and engine management systems. ndustrial applications include the letection of ferrous metals, proximity letection and current flow detection. With a very small sensor head and no requirement for external magnets or additional components, the KMI10/1 is small and rugged enough to be integrated into ball-and roller-bearings. Two KMI10/1 sensors operating together can be used to detect speed and direction, or to make incremental measurements.

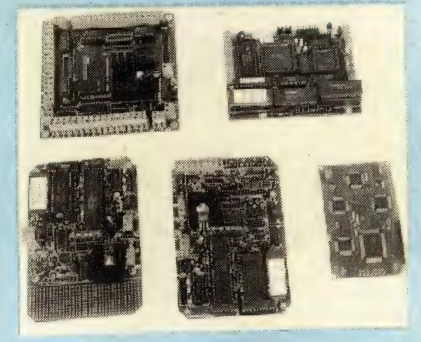
The KMI10/1 is a 2-terminal device which operates at frequencies from 0-25kHz, producing a pulsed current output at the tooth frequency. Unlike inductive sensors, the magnitude of this pulsed current (7mA in the low state and 14mA in the high state) is frequency independent. Only one low value resistor and capacitor are required to turn the output current into a TTL-compatible signal that is suitable for microcontrollers or other control logic.

For further information, contact Philips Components, 34 Waterloo Rd, North Ryde, NSW 2113. Phone (02) 805 4455.

Vivitar video fader/ audio mixer

This compact video fader can mix the sound from three separate sources as well as being able to provide a smooth fade-in or fade-out of a source such as a camcorder or VCR. The unit comes with its own microphone and is supplied with video and audio leads. It runs from an external 12V DC plugpack adaptor (not supplied).

The unit retails for $199 and is available from David Reid Electronics, 127 York St, Sydney NSW 2000. Phone (02) 267 1385 or fax (02) 261 8905.



Home control system from Cebus

Now available from CEBus Australia is the HCS II home control system as featured last year in the American magazine "Steve Ciarca's Circuit Cellar INK". The HCS II is a control system which monitors sensors and controls devices via the AC power mains. Such systems have been talked about for many years as the "intelligent home concept" but this is the first time that a dedicated system has become available.

Essentially, the HCS II transmits serial data over the AC power line via special isolating modems. You can program the system to control devices such as lights, heating systems and so on. The system uses a program language called Express and this is supplied on floppy discs.

Our photo shows some of the control boards in the system. Not shown are an LCD board (20 line display), the appliance module and modems, and the various cables which are supplied.

The price is $1442 plus tax where applicable for an assembled and tested basic system.

For more information, contact CEBus Australia, 26 Lambourn Rd, Watsonia, Vic 3087. Phone (03) 435 1185 or fax (03) 432 1825.

Kenwood's luxury L-A1 amplifier

Kenwood's new top of the line L Series hifi equipment is finished in a luxurious anodised gold fascia plate with hand-rubbed rosewood side panels.

Inside the L-A1 amplifier is a specially developed Super C4 (Super Constant Cascade Circuit) that represents a major departure from conventional differential amplifier design. The super C4 circuitry is claimed to reduce the in-phase noise in much the same way as the high CMRR (Common Mode Rejection Ratio) of differential designs but it produces a much cleaner

continued on page 83

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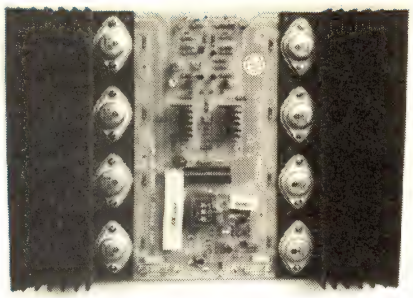
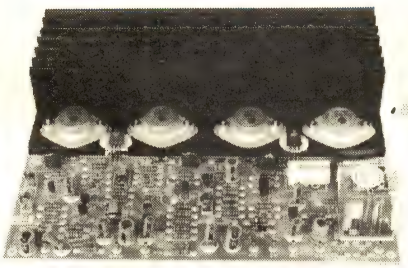
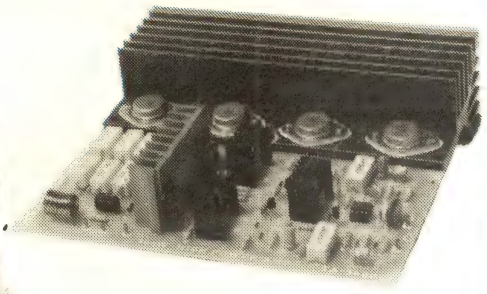


S0343 $299.00

S0342 $228.00





300 WATT MOSFET AUDIO POWER AMPLIFIER

Recent developments in high fidelity sound reproduction systems have occurred which place stringent demands on the power amplifier. Discriminating listeners have discerned subtle differences between solid state and vacuum equipment and most of them seem to prefer the vacuum tube sound. Moreover, the demand for ever higher output power has increased steadily.

There is now available the power MOSFET transistor which can provide extremely high output power together with the virtues of vacuum tube sound. However, in order to attain the high performance of which these devices are capable requires careful circuit design.

The acoustic fidelity laboratory design engineers have conducted extensive design and test activity in order to produce a superb product for the do it yourself audio enthusiast. With a reasonable amount of care taken in its construction, an amplifier rivalling the top of the line equipment may be realised at an extremely modest cost.

Specifications:

Power Output: 300W into 4 Ohms (0.1% THD)
200W into 8 Ohms (0.02% THD)
Frequency Response: 10 Hz - 20 KHz
Total Harmonic Distortion Less than 0.03%
Input Sensitivity and impedance at 1 KHz, 1V 47 K Ohms
Load Impedance: 4 - 16 Ohms
Power Requirements: ±55 to ±65V DC 8 A (Each Channel)
Dimensions: 287 x 205 x 60 mm
Weights: 4.62 lbs (2.1 kg)
Recommended Transformer: 45V + 45V, 500VA (T0265)

A TOTAL MIRROR-IMAGED, FULLY COMPLEMENTARY, 250W RMS, MOSFET AUDIO POWER AMPLIFIER

Power Outputs: 120 Watts (RMS) into 4 Ohms,
80 Watts (RMS) into 8 Ohms,
When 33V + 33V AC, 220W power transformer is used.
250 Watts (RMS) into 4 Ohms,
150 Watts (RMS) into 8 Ohms,
When 42V + 42V AC, 500W power transformer is used.

Frequency Response: 3Hz – 22,000Hz (±0.8dB)

Total Harmonic Distortion: Less than 0.03%

Input Sensitivity: 1 Volt input for full rated-output, at 1kHz, into 47K Ohms.

Load Impedance: 4-16 Ohms.

Power Requirements: 33V + 33V AC, 220W (Each channel) or
42V + 42V, AC, 500W (Each channel) or
±46VDC, 4A, ±60V DC 6A (Each channel)
(the a/m DC Voltages were measured at empty load)

Dimensions: 205 (W) x 60 (H) x 165 (D) mm

Weights: 2.64lbs (1.2kg)

Recommended Transformers:
30V + 30V, 225VA (T0242)
or 40V + 40V, 500 VA (T0264)

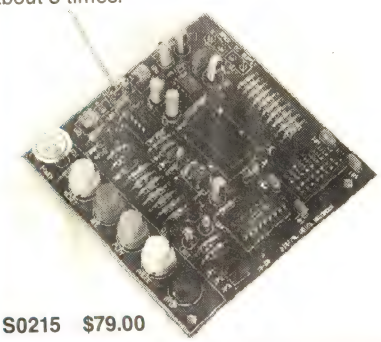
300W HI-FI POWER AMP(MONO) $0331 $175.00

Power Output:	300W RMS into 8 OHMS 500W Music Power into 8 OHMS
Frequency Response:	10Hz to 20KHz
T.H.D.:	Less than 0.05%
I.M. Distortion:	Less than 0.05%
Input Sensitivity:	1V RMS at 47K
Power Requirement:	+/- 60 to 75 VDC at 8A Mono 48-53x2/6-8AMP AC
Recommended Transformer:	50+50V/500VA. (T0225) MONO

SOLID STATE DIGITAL VOICE RECORDER

The S0215 is a digital solid state voice recorder. It uses the latest integrated circuits to perform the analog-to digital (A/D) and digital-to-analog (D/A) functions. It uses low-noise low-distortion analog integrated circuits to perform the low-pass anti-aliasing filtering and amplification functions.

The recording time, and therefore the playback time is determined by the memory capacity provided by the digital storage integrated circuits. Simple consumer type digital recorders almost always use 256K memory circuits. The recording time of these devices is limited to about 16 seconds. The S0215 has the ability to provide greatly extended recording time because it uses two megabyte memory circuits. Thus the recording time is extended by about 8 times.



S0215 $79.00

The S0215 is supplied with an electret microphone element and it is only necessary to provide a loudspeaker and simple power supply to make it fully operational.

Features:
1. 10 bit AD/DA conversion for accurate voice recording.
2. Extended recording time due to high memory capacity.
3. 3 LED indicators to display operational mode.
4. Switch control of Reset, Record, Playback, Pause and Stop modes.
5. Power requirements are modest 5 to 6 VDC.

A-ONE

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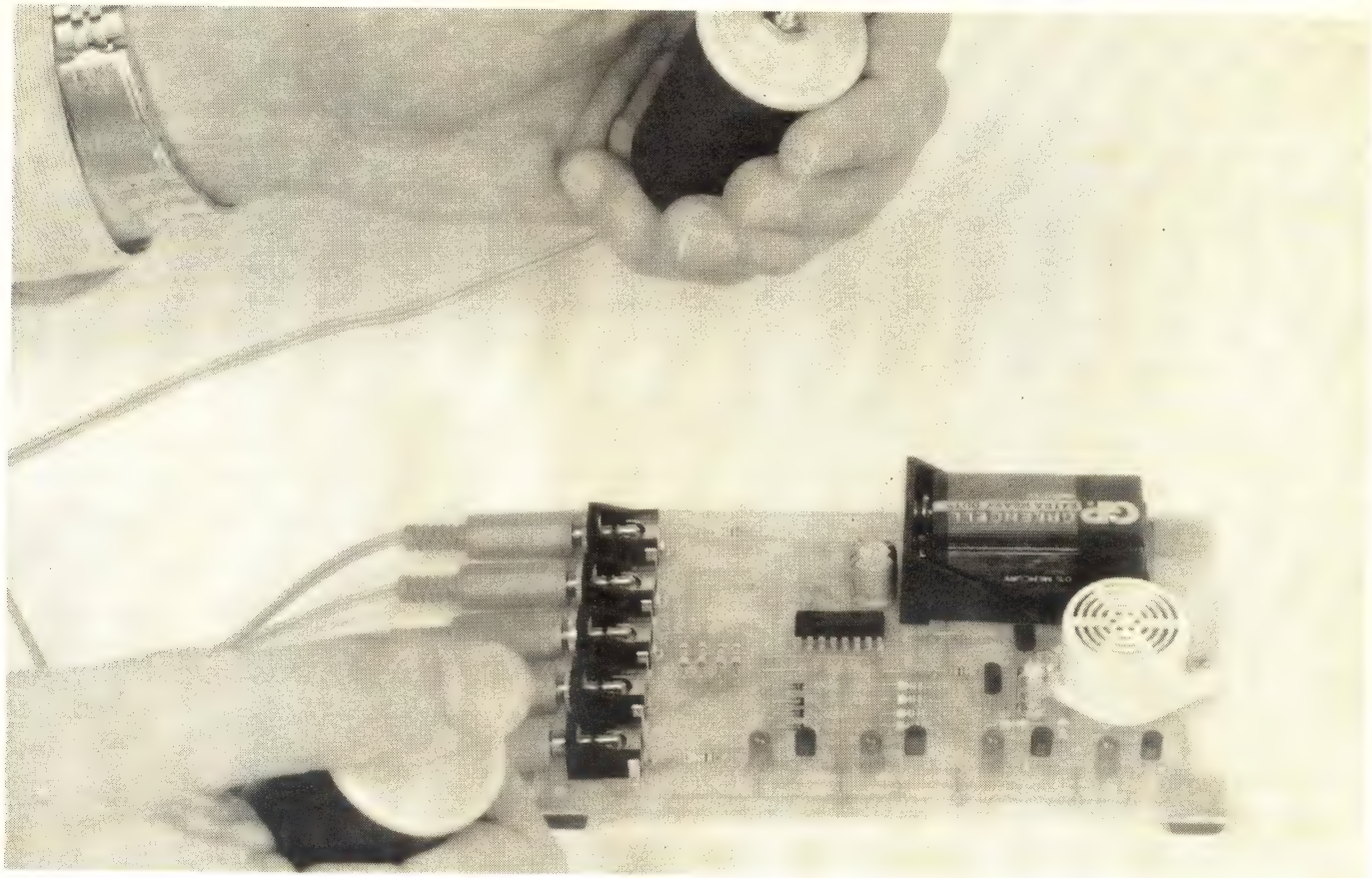


Build this low-cost quiz game adjudicator

If you've ever wanted to risk all the prizes and go for the cash jackpot, then this is the project for you. Called the Quizmaster, it lights a LED & briefly sounds a buzzer to indicate which of four players pressed the button first.

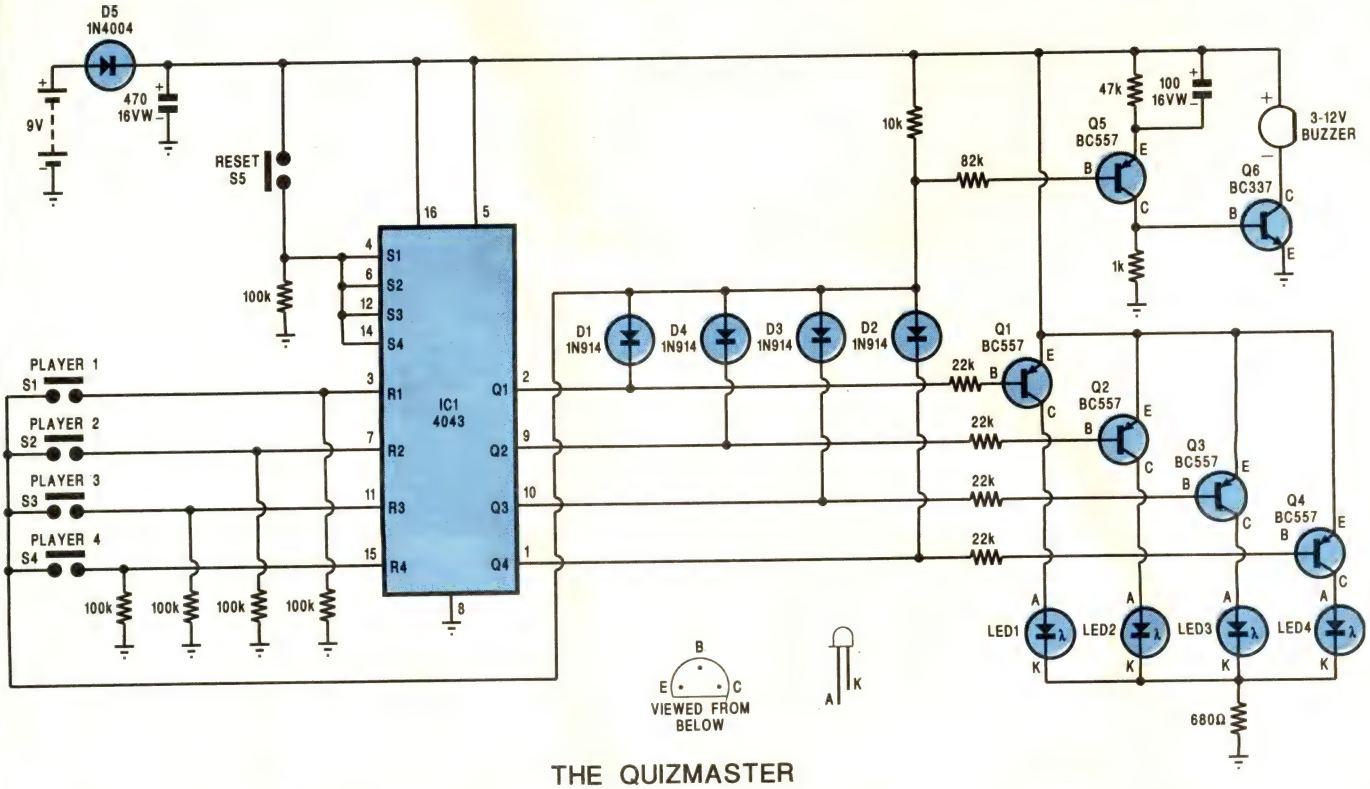
By DARREN YATES

Imagine it. You're sitting down with two other "brains" in the local Gulargumbone Sale of the Month Championships. You've just got to make it through the 60-seconds "fast money" and all the prizes are yours – a year's supply of toilet paper in your choice of pastel colours, a $100 gift voucher at Spud Murphy's second-hand farm machinery depot, all the icecream you can eat in a week, plus various other (mainly useless) household supplies. However, your eyes are firmly fixed on the cash jackpot which grows by $2.78 each night.

The compere, in thongs and stubbies, bellows out, "Hey, Raelene! What's tonight's grand total cash bonanza?" Raelene, regaled in the latest fashion wear from the local opportunity shop, informs the audience, most of whom are now asleep with excitement, "Tonight's bonanza is $38.75 minus the cost of the beer. We'll put the one minute up on the clock and your time starts ... now!"

Starting out $4.23 behind your opponent, you charge through the fast money as if you knew the answers before the questions were even asked. It comes down to the last question. You have to get in first and answer correctly or you lose the lot.

"What's the name of Bullhead Jones' prize pig?" Knowing full well that the answer is Beethoven, you thrust your arm towards the heavens, expecting to be awarded all the prizes.



THE QUIZMASTER

Fig.1: the circuit is based on IC1, a 4043 quad RS latch. When one of the PLAYER buttons (S1-S4) is pressed, the corresponding Q output of IC1 switches low & turns on its associated PNP driver transistor (Q1-Q4) to light one of the LEDs. Q5, Q6 & the associated 100µF capacitor are used to drive the buzzer.

Your opponent, whose arm was broken by a freak and mysterious accident during the last round, raises his plastered arm a full second after your own mighty effort. However, the compere who unbelievably loses his glasses just after reading the question, fails to see your arm rocket upwards and awards the question and all of the prizes to your opponent.

And the moral of this sorry tale? – if the compere had been given a Quizmaster, this would never have happened!

Circuit diagram

Let's take a look at the circuit diagram of the Quizmaster – see Fig.1. As you can see, it uses a single 4043 IC (IC1), a buzzer, and a few transistors and LEDs.

Inside the 4043 are four tri-state RS flipflops. The reset pins (R1-R4) are connected to their corresponding PLAYER buttons, while the set inputs are tied together and connected to the RESET button (S5). The circuit detects which of the four PLAYER buttons is pressed first and disables the other three buttons until the RESET button is pressed.

When S5 is pressed to start the game, the four set inputs are pulled high and so the Q1-Q4 outputs at pins 2, 9, 10 & 1 also go high. These outputs drive PNP transistor stages Q1-Q4 via 22kΩ current limiting resistors. Thus, when the RESET button is pressed, transistors Q1-Q4 will all be off and none of the LEDs will be lit.

IC1's Q1-Q4 outputs also drive a 4-input AND gate made up of diodes D1-D4. When all four Q outputs are high, the output of the AND gate is also high and thus Q5, Q6 and the buzzer are all off. This high is also applied to the commoned side of the four PLAYER buttons.

Normally, the four reset inputs on IC1 are held low by 100kΩ pull-down resistors. However, if one of the player buttons is now pressed, the high output from the AND gate is fed into the corresponding reset input and this causes the associated Q output to go low. This low then turns on the associated PNP driver stage to light the correct LED.

At the same time, the output of the diode AND gate goes low and this prevents any of the other switches

The four PLAYER switches are housed in discarded 35mm film canisters. Mount each switch on the lid of its canister & feed the connecting lead out through a hole drilled in the bottom.

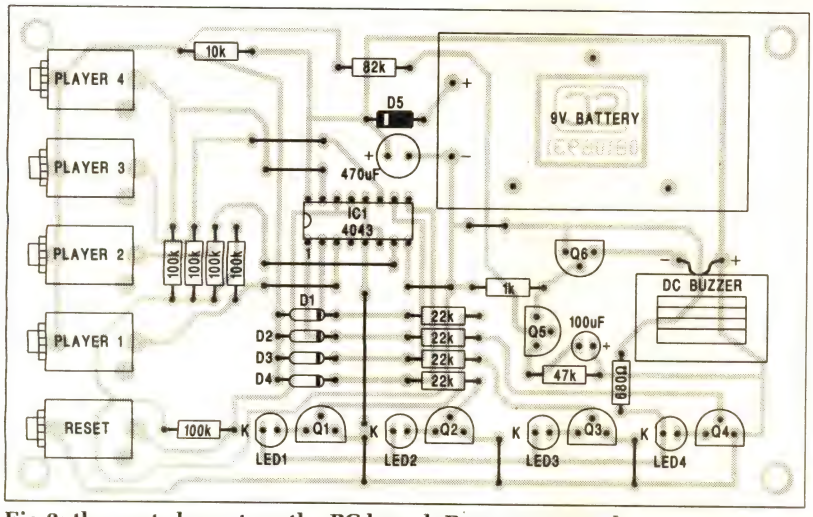


Fig.2: the parts layout on the PC board. Be sure to use the correct transistor type at each location & take care with the orientation of polarised components. The pin connections for the transistors & LEDs are shown on Fig.1.

from resetting its associated flipflop. This means that the remaining player switches are effectively disabled.

Transistors Q5 and Q6 form a simple monostable circuit which drives the DC buzzer. It works like this. When the output of the diode AND gate switches low (ie, when one of the PLAYER buttons is pressed), PNP transistor Q5 turns on and provides base current for Q6. This turns Q6 on and so the buzzer sounds.

The 100µF capacitor between Q5's emitter and the positive supply rail now charges via the 1kΩ collector resistor. As it charges, the current through Q5 tapers off and the voltage developed across the 1kΩ resistor drops. Eventually, after about 0.2s, it drops below 0.6V and Q6 and the buzzer turn off.

This means that the buzzer only gives a brief burst of sound, to indicate that one of the players has responded. The buzzer then remains off but the relevant indicating LED remains on to show which player pressed his/her button first. Pressing the RESET button now resets IC1 and turns the LED off again to rearm the circuit.

Power for the Quizmaster is supplied by a 9V battery via reverse-polarity protection diode D1. The circuit draws only a few microamps of current while in reset mode, so there's no need for a power switch.

Construction

All the parts for the Quizmaster, except for the five pushbutton switches, are mounted on a PC board coded 08106931 and measuring 144 x 87mm. Fig.2 shows the parts layout on the board.

Begin the board assembly by installing the 10 wire links. These should all be as straight as possible, to avoid possible shorts to other components. If necessary, you can straighten the link wire by clamping one end in a vice and then stretching it slightly by pulling on the other end with a pair of pliers.

The resistors, capacitors, diodes and semiconductors can now all be mounted on the board. Be sure to install the correct transistor at each location and check that the IC, transistors and capacitors are correctly oriented. The accompanying table shows the resistor colour codes but it's also a good idea to check them on a multimeter as some of the colours can be difficult to decipher.

PARTS LIST

1 PC board, code 08106931, 144 x 87mm
1 3-12V DC buzzer
1 9V PC-mount battery holder
5 PC-mount 3.5mm sockets
5 3.5mm plugs
4 rubber feet
5 plastic 35mm film canisters
5 normally-open momentary pushbutton switches
1 10-metre length of light-duty speaker cable
1 9V battery
4 self-adhesive rubber feet
2 3 x 10mm-long machine screws & nuts
3 8BA machine screws & nuts

Semiconductors

1 4043 quad RS latch (IC1)
5 BC557 PNP transistors (Q1-Q5)
1 BC337 NPN transistor (Q6)
4 1N914 signal diodes (D1-D4)
1 1N4004 silicon diode (D5)

Capacitors

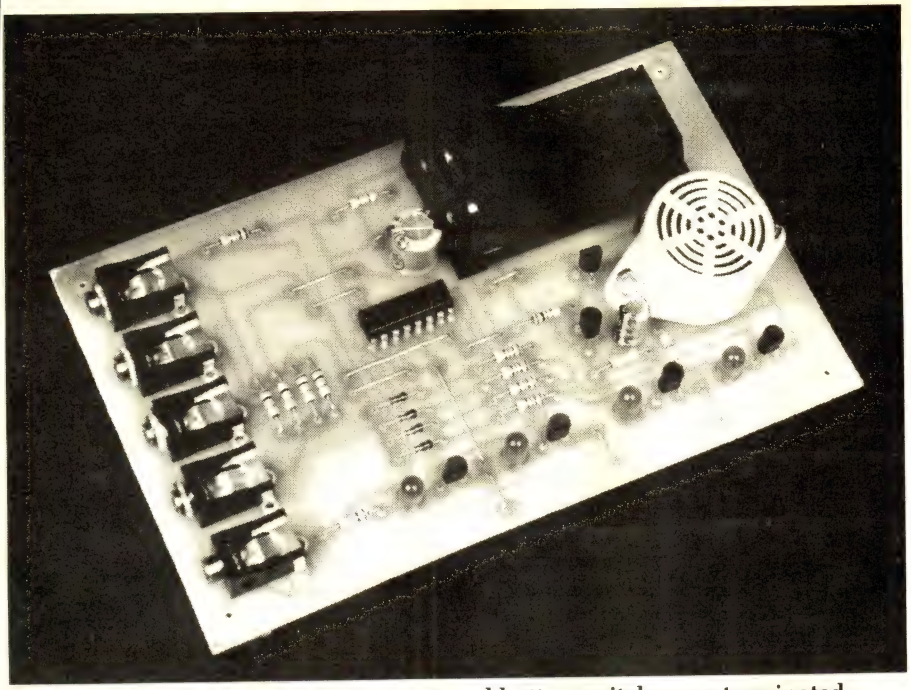
1 470µF 16VW electrolytic
1 100µF 16VW electrolytic

Resistors (1%, 0.25W)

5 100kΩ
1 82kΩ
1 47kΩ
4 22kΩ
1 10kΩ
1 1kΩ
1 680Ω

RESISTOR COLOUR CODE

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	5	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	82kΩ	grey red orange brown	grey red black red brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	4	22kΩ	red red orange brown	red red black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	680Ω	blue grey brown brown	blue grey black black brown



The leads from the momentary contact pushbutton switches are terminated with 3.5mm plugs & these go to matching 3.5mm sockets on the PC board.

Once these components have been mounted, install the battery holder, the buzzer and the five 3.5mm sockets. The battery holder is secured to the PC board using three 8BA screws and nuts, while the buzzer is secured using two 3mm x 10mm screws and nuts, with two additional nuts used as spacers. You will have to drill two mounting holes in the PC board to suit your particular buzzer.

The five pushbutton switches are housed in discarded 35mm film canisters – see photo. All you have to do is drill a hole in the lid of each canister to accept the switch, plus an exit hole in the base of the canister for the switch lead.

The switch leads can each be run using two metres of light-duty speaker cable. These leads are terminated with 3.5mm mono plugs to match the sockets on the PC board.

Finally, the PC board can be fitted with four rubber feet and the input sockets and LEDs labelled with their corresponding player numbers. This labelling can be done using transfer lettering or a suitable marker pen.

Testing

To test the unit, plug in the external switches and install a 9V battery. The circuit should now fire up in one of two ways – either with all the LEDs lit or with all the LEDs off. This may sound a bit imprecise but the initial state of the circuit will depend on the state of the flipflops inside IC1.

If all the LEDs are on, check that they all go out when the RESET switch is pressed. Now check that the buzzer briefly sounds and that the appropriate LED comes on when one of the PLAYER switches is pressed. The remaining PLAYER switches should now have no affect on the circuit and the LED should remain on until the RESET switch is pressed again.

If it doesn't work, first check that all components are correctly positioned and that there are no missed solder joints or solder splashes on the copper side of the board. This done, check that pins 5 & 16 of IC1 are at +9V when the battery is installed.

If one of the LEDs fails to light, check its associated driver transistor and check that the LED has been correctly oriented. Similarly, if the buzzer fails to sound, check the circuit around transistors Q5 and Q6. In particular, note that Q5 is a PNP type while Q6 is an NPN type so don't get them mixed up. **SC**

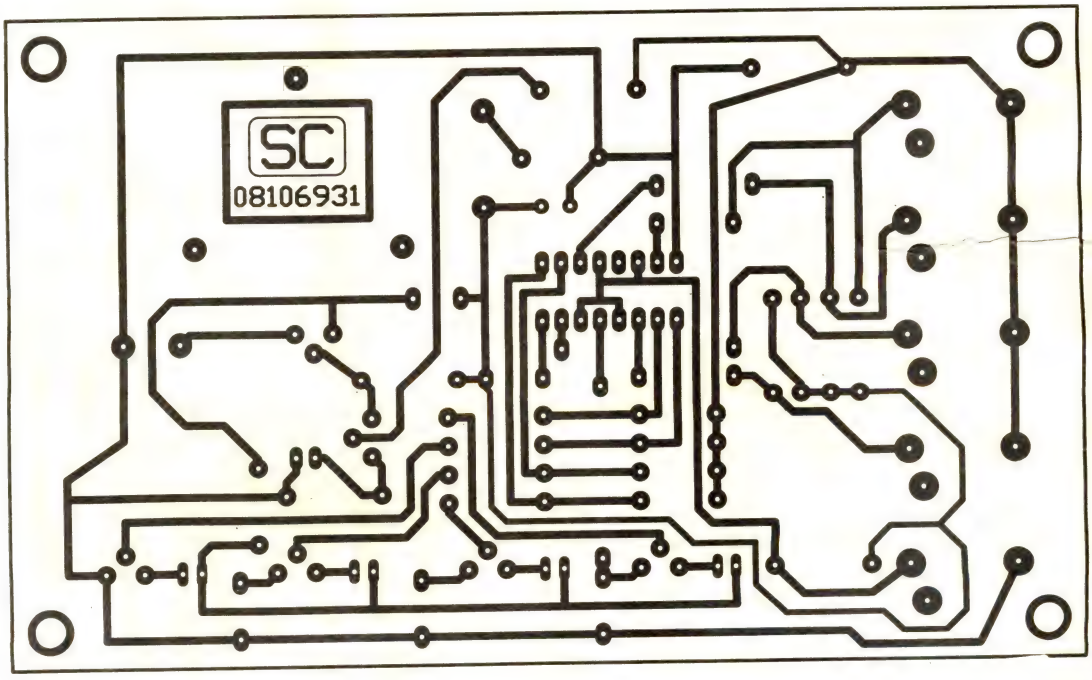


Fig.3: this is the full size pattern for the PC board. Check the etched board for track defects before mounting any of the parts.

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Equivalent (Bourns 3540S Beckman 7256)
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R14055 100R R14110 10K
R14060 200R R14120 20K
R14070 500R R14080 1K
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PN200 REPLACES:

PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4248, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N2905A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447.

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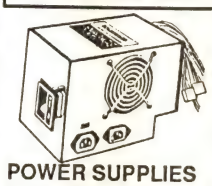
Z10107	IN4004	$0.08	$0.06	$0.05	$0.04
Z10110	IN4007	$0.10	$0.07	$0.06	$0.05
Z10115	IN5404	$0.18	$0.14	$0.13	$0.11
Z10119	IN5408	$0.20	$0.16	$0.15	$0.14



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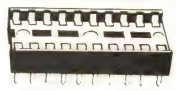

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P10569	22pin	35¢	30¢	26¢
P10570	24pin	35¢	30¢	26¢
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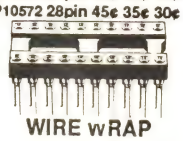

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P12167	$1.50	$1.20	$1.00
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7905UC	$0.60	$0.55	$0.50
7912UC	$0.60	$0.55	$0.50
7915UC	$0.60	$0.55	$0.50
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555	$0.40	$0.38	$0.33
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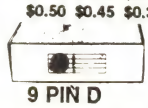

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Z10143(Y)..	$0.20	$0.18	$0.15	$0.
Z10145(O)..	$0.20	$0.18	$0.15	$0.

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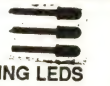
Z10151(G).	$0.25	$0.20	$0.18	$0.
Z10152(Y)..	$0.25	$0.20	$0.18	$0.



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BC 548	$0.15	$0.10	$0.07
BC 549	$0.15	$0.10	$0.07
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BC 558	$0.15	$0.10	$0.07
BC 559	$0.15	$0.10	$0.07
BC 327	$0.20	$0.15	$0.12
BC 337	$0.20	$0.15	$0.12
BD 139	$0.75	$0.60	$0.50
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These terminals feature interlocking ends to form any number of connections. Standard 5mm spacing pins.

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245M	YES	12ms	SEAGATE/WD.	$569
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It's also ideal for keeping the kids out of your computer!
The Floppy drive comes in both3 1/2" and 5 1/4" sizes.
3,1/2" Lock
C12578.....$39.95
5 1/4" Lock
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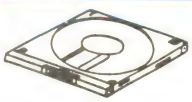

The more CD's are out of there protective covers the more risk there is of damage through dust and scratches.
Avoid damaging your CD ROMS by always storeing them in these Caddies that slide straight into your CD ROM.
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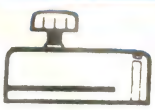

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Converts a 5 1/4" single sided floppy to a double sided floppy by placing an appropriate notch in the floppy disk jacket.
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It takes only a minute amount of dust, dirt or magnetic oxide particals on your drive heads to cause problems, errors downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt.
it's simple to use & includes cleaning solution & instructions.
3 1/2" C12560..... $4.95
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Protect your 5.25" diskswith these disk envelopes Qty 25
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DISK LABLES

(To fit 3.5" disks)
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To fit all 5.25" disks
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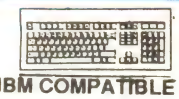

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Keyboard and mouse in one
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Prevent your eyes from damages.
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Great for saving a serial port. 2 Free telepaint disks.Save $30 ONLY
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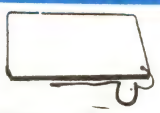

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Wipe clean static electricity . Each mat includes a coiled alligator clip. Decreases friction. Accomodates the whole keyboard.
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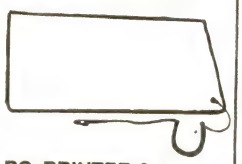

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23.5" X 23.5"
Accomodates the whole PC, priter and keyboard.
.....$29.95

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3.5" HARD DRIVE MOUNTING KIT

2 Universal brackets with screws to mount 3.5" hard drives into computer cases **X19971....$9.95**

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HD-15P MALE-MALE
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S: STRAIGHT TYPE
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DB-9P FEMALE TO HD-15P MALE
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X15684.....$12.95
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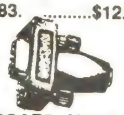

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X15673.....$14.95
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X15674.....$14.95
DB-25P-MINIDIN PIN 6P
X15675.....$14.95
DB-25S-MINI DIN 6P
X15676.....$14.95

IBM MONITOR/ KEYBOARD ADAPTOR
DB-9P-DIN TO 5P DIN 5P
LENGTH 15CM
P39591 ..$14.95

THIS IS JUST A SMALL SAMPLE OF THE GENDER CHANGERS WE HAVE IN STOCK!

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MORE HANDY PRODUCTS FROM ROD IRVING ELECTRONICS

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VISIBLE ALARMS ARE BETTER DETERENTS

Xenon strobe flash with screw mounting base. Useful for mounting on or next to alarm sirens etc. for added security.
Connections are made through the base so all wires are hidden.
- Flash rate: 120 per minute.
- Operating voltage12VDC.
- Current draw: 150mA
- Dimensions : 90 (dia) x 105(H)mm

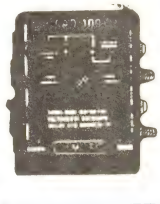
A15044 BLUE
A15047 RED.....$37.95

ATTRACTS INSTANT ATTENTION

ROTATING WARNING LIGHT-BLUE

Motor driven rotating reflecting mirror with large waterproof lens ensures this will be seen in emergency or alarm situations. Wire connections are made through the base so all wires are hidden.
- Rotates 150 times per minute.
- Shock absorbing rubber mount legs.
- Operatng Voltage: 12VDC,
- Current draw: 750mA
- Dimensions 102(dia) x 140(H)mm

A15042.....$49.95



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Designed to test balanced and unbalanced cables with three pin XLR connectors as well as leads with 6.5mm phone or RCA plugs. Ideal for checking patch leads and long cable runs before they can damage equipment. Operates wih a single 9 volt internally mounted battery and utilizes easy to read LED's for quick readings whilst out on the job.
A10532.....$50.00

TAKE THE TV OUTSIDE BY THE BBQ

EXTENTION 75OHM FLYLEAD-10M

Here's how to get your TV out on the back patio or out by the pool. Simply Unwind the ten metre extention lead from its handy dispenser and extend your antenna to where ever you want to go. Colour White
P32180.....$29.95

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KEY LOCKDOWN ANTENNA
- 4 Sections
- 860mm long extended
- 1.2metre lead with plug

A12061.....$8.95

ANTENNA WITH SPRING BASE
- Three sections
- 1.4 metre long exteded
- 1.2 metre lead with plug

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TOP COWL ANTENNA
- Single section
- 1 Metre long extended
- 1 metre lead with plug

A12068.....$9.95

PILLAR MOUNT
- Suits Mazda, Nissan, and Toyota.
- 1.2 metre long extended
- 1.2 metre lead with plug

A12064.....$8.95

RUBBER DUCKIE

Black flexible rubberised antenna for the car, truck or boat. Flexability prevents damage from low trees.
- Single Section
- Conductive Rubber body
- Bonnet or boot mount
- 400mm long
- 1.2 metre lead with plug.

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Contains three pairs of different sized mounting brackets for car stereos CB's and other communication equipment in the car or truck etc.
- Includes support/earthing strip.
- Hardware supplied nuts, bolts, screws lockwashers.

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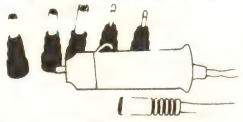
With on/off switch & separate control lead for remote operation of the cassette player. Complete with desk stand for hands free operation.
A10126.....$5.95

DC POWER LEADS



DC TO DC POWER LEADS

2 metre DC Power Lead with inline 5 amp fuse - Black.
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- Output: 2.1/2.5/3.1mm DC or 2.5/3.5mm phone plugs

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A HIGH QUALITY AUDIO AMP IN A 9 PIN FLAT PACK.

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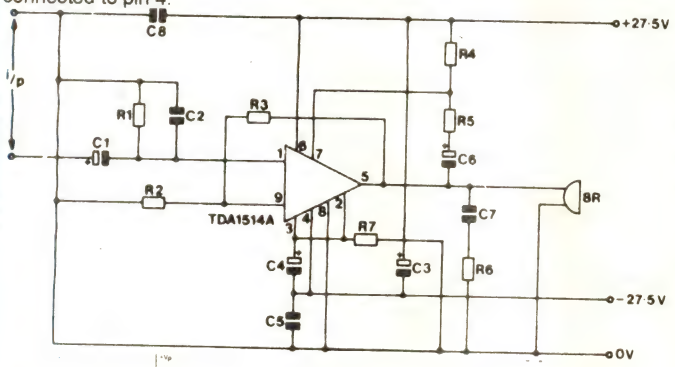
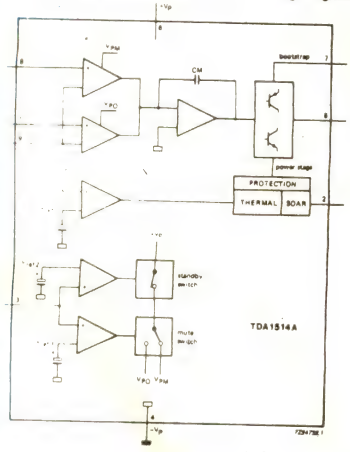
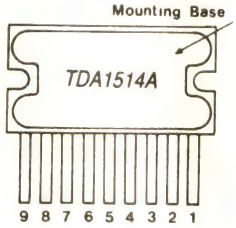




Mounting Base



Parts List		Cat No.
R1,3	Min Res 22kΩ	R10062
R2	Min Res 680Ω	R10044
R4	Min Res 82Ω	R10033
R5	Min Res 150Ω	R10036
R6	Min Res 3.3Ω	R10016
R7	Min Res470k	R10078
C1	PC Elect 2.2µF 100V	R15427
C2	Ceramic 220pF	R15328
C3,4	PC Elect 47µF 63V	R15525
C5,8	Green Cap 0.47µF	R15168
C6	PC Elect 220µF 35V	R15543
C7	Green Cap 0.022µF	R15152

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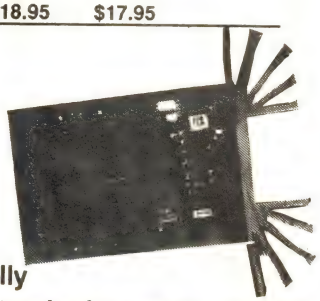

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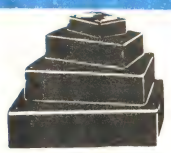

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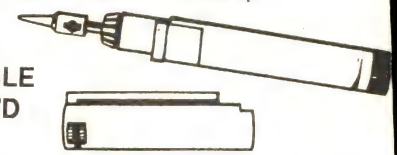

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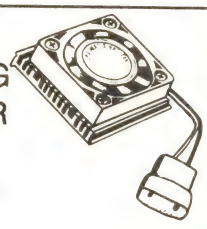
An electronic Counter Module with 5-digit LCD display. The display increases by 1 everytime a positive-going edge is applied to pin 3. A reset is available, and a tone output which can drive a piezo sounder directly and bleeps on every count and on reset. Square wave output at 512Hz and 32768Hz are also provided.
Count Range: 00000 to 99999 (resets to 00000 after counting 99999)
*1 to 1.5 input Voltage, *Min. imput pulse <100µs *2µA standby *32.768KHz *Max imput Frequency 7Hz
Overall Size: 68 x 35 x 24 mm
bezel is available for use with this module, size 68 x 35 mm and increases the overall depth of the module to 27mm. The module requires a 1.5V AA cell (not supplied).

COUNTER..A10070.....$39.95
BEZEL..A10075.....$1.95

COOLING CAP FOR INTEL 486 CPU



Here's the latest device for cooling your CPU. The cooling cap is a small fan which incorporates a heatsink which clips over the CPU with the plastic clip provided. No longer will you have to worry about hot CPU's. This model is much simpler than earlier versions where you had to remove the CPU to connect the fan. With this model you simply clip the fan on. Comes with a piggy back plug.
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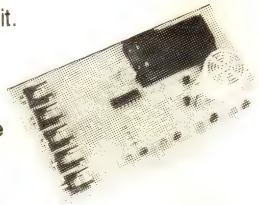

K10390.....$29.95

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K10395.....$65.95

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(ETI445) (ETI July '76)

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Of course there are other solar chargers around, but these are extremely expensive. With the ETI-569 the emphasis is on simplicity and cheapness.

K10005.....$13.95

TRANSISTOR TESTER

Have you ever desoldered a suspect transistor only to find that it checks OK? trouble shooting exercises are often hindered by this type of false alarm, but many of them could beavoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept. '83) 83TT8

K10080.....$22.95

ELECTRIC FENCE KIT

Main to battery powered, this electric fence controller is both inexpensive and versitile. Based on an automotive ignition coil, it sould prove an adequate deterrent to all manner of livestock. Additionally it's operation conforms to the relevant clauses of Australian Standard 3129. (EA Sept. '82) 82ef9

K10110.....$23.95

100 W AMPLIFER MODULE (ETI 480)

Similar to the above module but this one is 100 watts of power.
Heatsink optional extra

K10045.....$32.95

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K10130.....$155.00

ELECTRIC FENCE CONTROLLER

Restore the discipline to the farm or allotment with this new electric fence controller. It features higher output power and lower current drain than the previous design. (EA Dec. '85, 85ef11)

K10115.....$61.95

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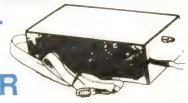
S.C. May '88.

K10355.....$55.00



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Here's the design for a low cost RGBI to PAL video encoder and RF modulator, suitable for use with an IBM or compatible computer fitted with a colour graphics adaptor (CGA). By providing a modulated RF signal on a suitable television channel, it allows a standard colour T.V receiver to be used as a colour monitor for games etc. E.A August '89.

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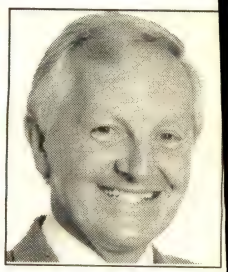


Unmanned aircraft: current models in service

Over the last decade, unmanned aircraft have come into their own & this was demonstrated to great effect in the Desert Storm campaign in the recent Gulf War. Some of these craft are little more than model aeroplanes but they are extremely effective nonetheless.

In last month's column, we looked at the development of unmanned aircraft (UMAs) over the past 80 years and noted the very fine line between UMAs and primitive guided missiles. This distinction is even closer when the modern glide bomb (smart bomb) is considered. With this we are virtually back to the MISTELN concept discussed last month in which a mother ship carries an unmanned fighter to the target vicinity, launches the fighter and guides it to the target.

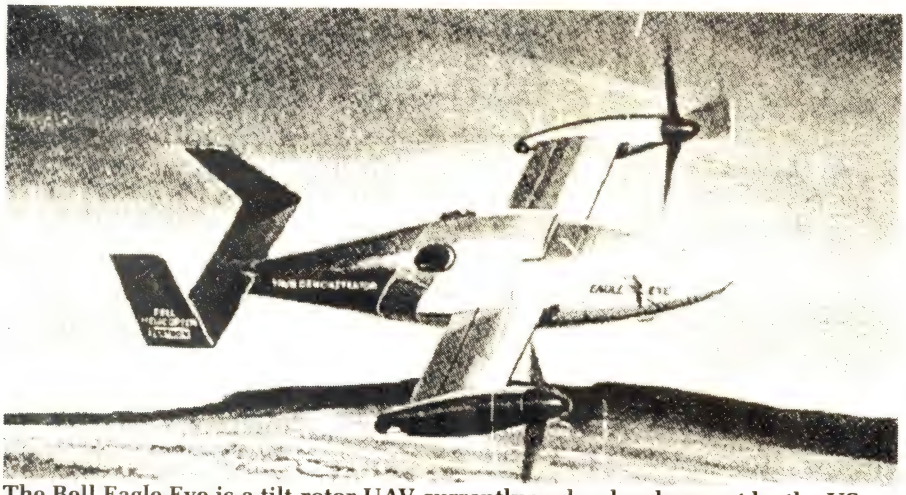
This concept was used by the Germans in WWII with limited success. But the smart bomb was used in the Iraq campaign, again guided from a mother ship, this time with great success. Hardened aircraft shelters (or HAS) proved totally ineffective against these devastating weapons and once again the shape of warfare has shifted and moved on to the next concept.

With this blurring of lines of demarcation we are faced therefore with the need to define what we mean by the term RPV, the new buzzword for UMAs. Remotely Piloted Vehicles (RPVs), as the term suggests, covers any vehicle capable of being controlled at a distance from the actual operator. My full-size remotely controlled Volkswagen 1600TLE was strictly speaking an RPV. Thus, the term UAV (Unmanned Aerial Vehicle), another modern buzzword, is probably the more correct term for use in this series of articles.

There is a further general agreement on the distinction between the various types of UAVs and these fall broadly into aerial targets, the aerial component of a complex battlefield system and finally, guided weapons.

As we have already noted, the days when UAVs were of value only for target practice have long since passed but these still comprise a major grouping and probably the missile target is the most sophisticated of this group. The Australian made Jindivik is one of the most successful of this class of UAVs. However, it is the middle group which forms the basis of this month's article.

It is the value of the UAV as a force multiplier that has become increasingly recognised since the Vietnam War; in other words, its value as a component in a complex battlefield system. This outlook was significantly enhanced as a result of the Israeli experiences and further as a result of the Iraq War. These events showed a growing need for military equipment, especially in the areas of surveillance, electronic warfare and post-strike damage assessment, that does not require a human crew to be exposed to enemy weapons. Here we have a very sophisticated class of UAVs capable of a multitude of tasks which in many cases have great commercial potential. One idea which has intrigued me



The Bell Eagle Eye is a tilt-rotor UAV currently under development by the US Department of Defence. It is to be powered by a 313kW turboshaft engine.

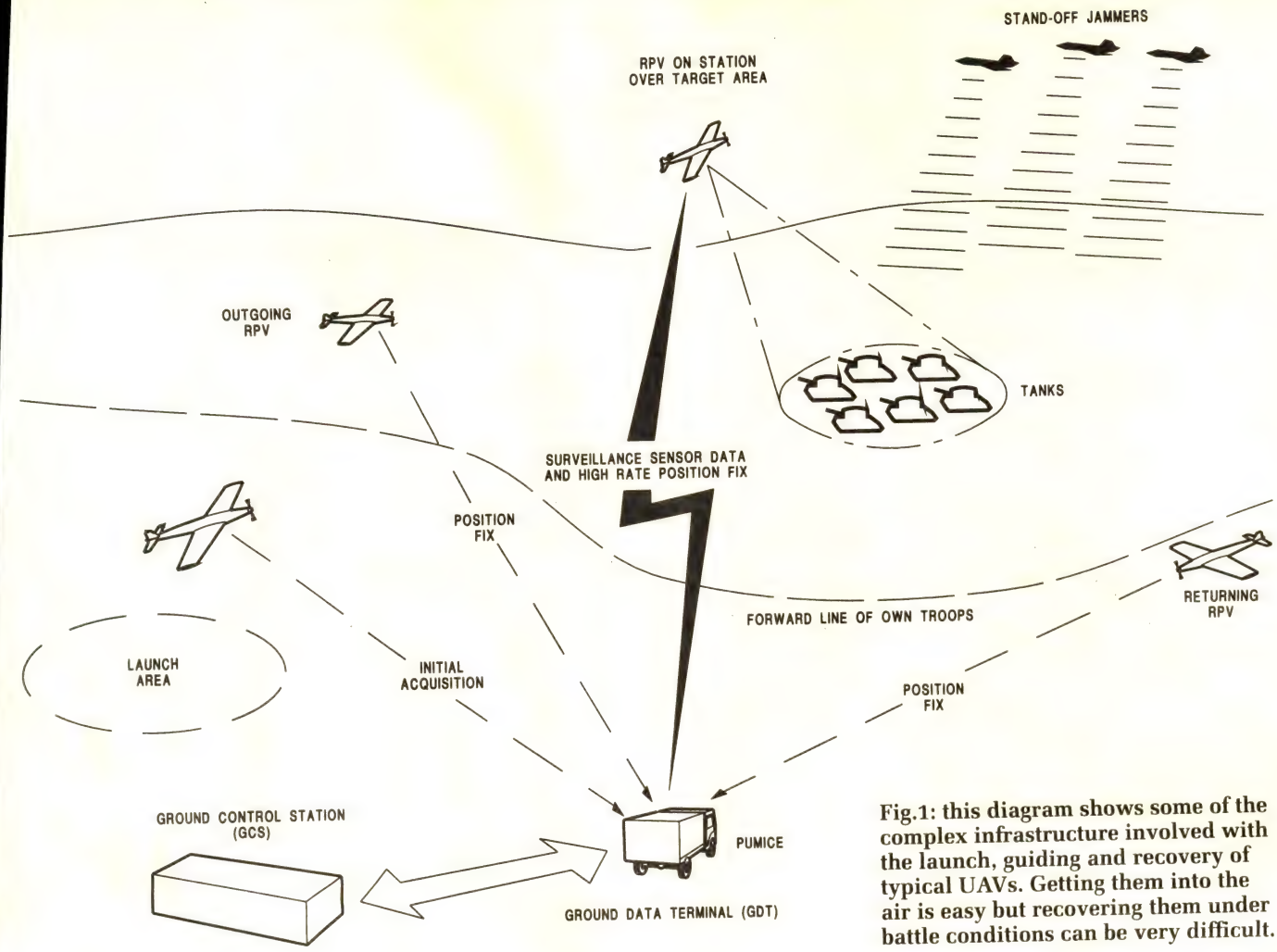


Fig.1: this diagram shows some of the complex infrastructure involved with the launch, guiding and recovery of typical UAVs. Getting them into the air is easy but recovering them under battle conditions can be very difficult.

for many years is the concept of a very fast courier service using small UAVs for cross city delivery of small parcels. Some of the vertical take off and landing UAVs would be ideal for this service.

What must be remembered with this class of UAV is that they are not independent vehicles but are merely the aerial component in a very complex system and thus comprise the middle grouping of the above classification. This system can be comprised of fixed or mobile control and mission planning stations, launch and recovery equipment or vehicles, transporters and data receiving and processing terminals (see Fig.1).

The problems of launch and recovery are major in a combat situation and force a further division into subclasses and in many instances, they influence the design of the UAV itself. A good example of this is the development of the TRUS (Tilt-Rotor study and demonstration UAV system) program. This project is intended to provide ship-based vertical take off and landing UAVs for OTH (Over The Horizon) surveillance and targeting for USN and NATO surface vessels.

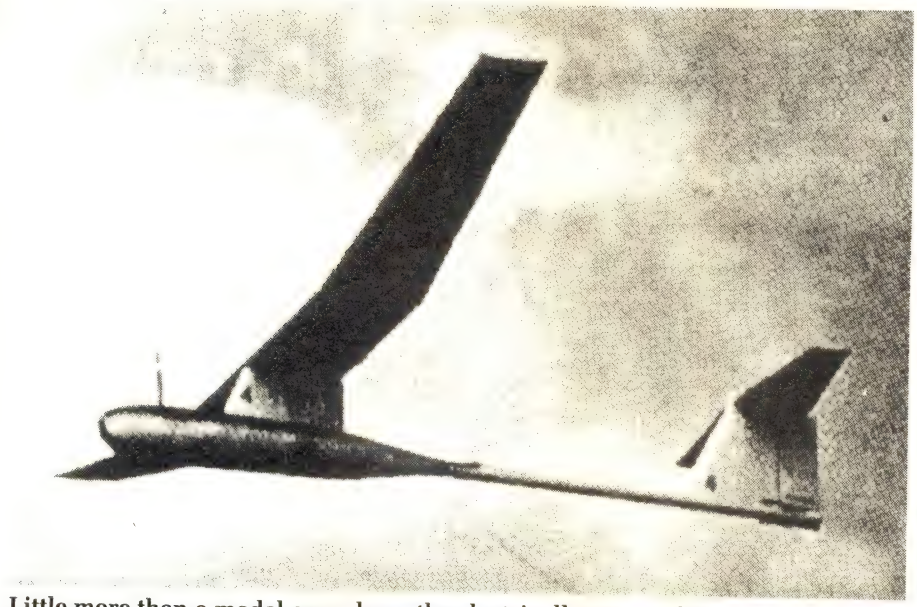
This program also provides an excellent example of the complexity and sophistication not only of the UAV itself but of the business network required to bring such a complex unit into being. In the second half of 1991, the Bell Helicopter division put together a design proposal for a little Tilt Twin Rotor Vehicle much along the lines of the much troubled Osprey Tilt Rotor Transport aircraft.

Named the "Bell Eagle Eye", the span over rotors is approximately 5.9 metres and the length 4.9 metres. Power comes from one Allison turboshaft rated at 313kW. The Bell team includes Israeli Aircraft Industries, TRW, Allison, Honeywell, Unisys, Scaled Composites and the Stratos Group. IAI contributes the ground control system, data link, mission computer and payload. TRW contributes payload trade-offs, antenna simulation and interoperability, Honeywell the AHRS and other avionics. Unisys integrates shipboard command/control with the airborne data link, while Stratos provides the operational interface.

Burt Rutan (Scaled Composites Inc), the famous designer of the around the world lightweight aircraft, is building two Allison-powered airframes and the test flights were scheduled for the second half of 1992. To date, I have seen nothing of the results of this project but the above outline gives some idea of the complexity and sophistication of the modern UAV.

Take off & landing

Vertical take off and landing is only one approach to the launch and recovery of UAVs. Launch is also quite commonly by conventional take off (ROG, rise off ground), hand launch, aircraft launch, catapult launch or any of several other methods. In other words, getting the thing into the air is easy. Recovery, however, is another



Little more than a model aeroplane, the electrically powered Pointer UAV is in service with the US Army and was used extensively for surveillance during Operation Desert Storm, Desert Sabe and Desert Shield. It uses a CCD video camera.

matter. Battles are rarely fought in ideal terrain and landing conventionally is usually out of the question. The situation for the over-the-horizon UAV is not so bad and any suitable smooth field within operational range will suffice as a miniature airfield.

The smaller, shorter range UAVs and, in particular, ship-launched units have real problems with recovery and thus recourse to parachute and net recovery is most common. The problems of shipboard recovery have forced the development of the vertical take off and landing UAV more than any other factor. Try landing a speeding UAV into a small net rigged on the heaving deck of a ship at sea.

In fact, the recovery problem and reduced safety requirements have brought about a revolution in UAV design. Because the vehicles are actually unmanned, the airframe designers have been given virtually carte blanche in regard to airframe and aerodynamic considerations. This has spawned a wild profusion of the strangest shaped vehicles yet seen on planet Earth.

There are flying saucers (or more correctly, flying doughnuts), flying balls, flying venturis, flying torpedoes, flying peanuts, deltas, canards, tandem wings, tractors, pushers, helicopters, tilt rotors and on and on; an endless stream of creative designs intended to solve awkward problems. If the aerodynamics of these vehicles ever finds their way into manned flight (and I believe they will), we will see some very interesting developments in airport design in the near future.

"Because the vehicles are actually unmanned, the airframe designers have been given virtually carte blanche in regard to airframe & aerodynamic considerations".

From the modeller's point of view and in fact the military point of view, possibly the most interesting modern UAV is the Aerovironment FQM-151A semi-expendable hand-launched mini UAV.

Here is a sailplane straight from the pages of Airborne or any other modern model magazine. Its wingspan is 2.74m, length 1.83m, launch weight 3.6kg, payload 910g and it is powered by a 300W samarium cobalt electric motor. (I wonder if they need a good speed controller?) The electrons for this motor are supplied by two lithium batteries which will keep this handy little vehicle moving for 1.25 hours at a maximum speed of 80km/h. Cruising speed is around 35km/h and maximum rate of climb 3.1m/s. The usual operational altitude is in the range of 50 to 300 metres.

Every aspect of this UAV is novel and militarily salient. The unit was designed to be operated by one man with a second assisting. The complete system breaks down into two back packs. The first contains the aircraft and the second the shoulder-mounted control/monitor system.

The UAV dismantles into six parts and can be reassembled in just 2.5 minutes. It carries a fixed focus TV camera in the nose, angled downwards at 20 degrees from the aircraft's centreline and giving a 22 x 30 degree field of view. It is radio-controlled over an 8km radius and is gyro stabilised. The Pointer is steerable by the monitor and is landed from the deep stall after engine shut down.

The monitor/control system is very interesting and appears very much like a shoulder mounted peep show. The monitor is mounted on shoulder braces which place it at face height in front of the pilot. It is completely sealed from light and the pilot looks into the peep window at the monitor screen. The flight controls are mounted on the side of the monitor housing. The transmitter is ground based or portable. This simplicity and flexibility of operation allows some novel uses for the Pointer.

The UAV can move to the target under power, which being electric is very quiet, then glide with the motor off to within close range of the target. The motor is then restarted and the UAV climbs away back to base. Being semi-expendable it does not matter if it is brought down by enemy fire at this point. The data it sniffed out is already back home, as the system is a real-time surveillance unit.

The camera is a CCD type with resolution of 350 x 380 lines. There are two monitor screens, one showing UAV heading and the other the target information. The monitor is backed up by a Sony 8mm cassette recorder with stereo audio channels, replay with freeze framing, fast slow motion and aircraft heading.

The number of uses for this system seems inexhaustible and has continually expanded since being adopted by the USMC in 1988. Designed primarily for reconnaissance, surveillance and target spotting, the list has grown to include evaluation of the effectiveness of the concealment techniques of US ground troops. Thus, any unit digging in will launch a Pointer to check its own camouflage from the air and to maintain perimeter security. In the Iraq war, it was operated by the US Army 82nd Airborne Division, 4th M Expeditionary Brigade and the 1st and 4th M expeditionary Force as part of Operations Desert Shield and Desert Storm.

Used in the above manner for the first time, it was also used for real-time battle damage assessment, reconnaissance, surveillance and advance warning of enemy movements.

Another novel use for Pointer is from a ground vehicle. In this manner, the UAV and pilot can extend the range, depending on the terrain, to around 50-65km, whilst maintaining an operational field of view of up to eight kilometres ahead of and around the ground vehicle; very handy for convoys and armoured columns.

However, the Pointer is not without its drawbacks and there were reports of launch difficulties due to high winds. This problem of high winds and low cruise speeds is a serious one for all aircraft, as effective ground speeds can very quickly drop to zero. Thus, a Pointer cruising at 35km/h into a 35km/h headwind has a ground speed of 0km/h, whereas a UAV with a 70km/h cruise speed will still have a ground speed of 35km/h and therefore will be able to accomplish its mission, albeit with a reduced range or loiter time. When cruise speed reaches hundreds of km/h, headwinds become less of a problem.

Improvements

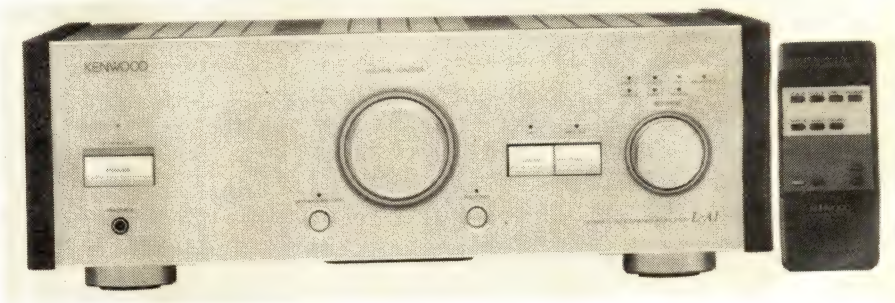
These problems aside, the Pointer appears to have a good future and improvements are already in the system. These include automatic heading and altitude hold, spread spectrum transmission to minimise threat from ECM, increased range (16km), endurance (2 hours) and flight speed. Reduction of airframe and payload weights are also in the pipeline, as is a twin-engined version. All in all, this is a very handy little unit for what is essentially a toy aeroplane.

Pointer also has a big brother, the HILINE, which is a high altitude long endurance (HALE) UAV for acquisition and tracking of hot airborne targets (launched ballistic missiles, etc). At first glance, the figures on this UAV appear fantastic, with a typical mission profile as follows: carry 45kg payload for 800km, loiter for more than 24 hours and return; range more than 4830km with an endurance of approximately 20-30 hours; range 100km from launch at 25,000 feet; or fly for 15-20 hours at 40,000 feet.

The wingspan of this UAV is quoted as 15.24 metres and maximum take off weight as 341kg. It is powered by one 31kW Ackerman OMC-200 turbocharged 2-cylinder engine. Whilst on the subject of high altitude UAVs, I have seen mission profiles *calling* for altitudes in excess of 100,000 feet from piston engined UAVs. How they get a piston engine to breathe at that altitude is beyond me.

However here we are again at the end of the allocated space. Next month we will continue with a discussion on the really exotic UAVs. **SC**

Product Showcase – ctd from page 67



signal. The end result is that the L-A1 boasts one of the quietest phono stages found in an integrated amplifier irrespective of price.

Another outstanding feature is a newly developed master volume control with an unusually low impedance of only 1kΩ. Such a low impedance design reduces thermal and other types of noise to the order of one tenth of traditional designs.

Power output is rated at 100 watts RMS from a push pull parallel Darlington design that employs a group of driver transistors for each power section. All stages prior to the output sections are class A. The power output sections are powered by a specially designed toroidal transformer with extremely low magnetic leakage and massive 18,000μF reservoir capacitors that have been specially selected for their outstanding electrical and musical properties. The main amplifier board and phono section boards are glass epoxy, Kenwood claiming that this new material offers excellent electrical characteristics and better rigidity than phenolic resin board.

Specifications include 100 watts RMS per channel, with both channels driven into 8Ω from 20Hz to 20kHz with no more than 0.005% THD. Dynamic power is up to 420 watts into 2Ω. The frequency response is 3Hz to 100kHz at the -3dB points, while phono RIAA response is from 20Hz to 20kHz within ±0.5dB.

The Kenwood L-A1 stereo amplifier is covered by a 12-month warranty on parts and labour and has a recommended retail price of $3999. For further information, contact Kenwood Electronics Australia Pty Ltd by phoning (008) 251 697.

Nifty little magnifier

This combined magnifier and tweezer set is very handy when you have to examine PC boards for cold solder joints and also to examine the lettering on those teensy-weensy components. And even if you never touch a PC board, it is ideal for getting splinters out of fingers. It sells for just $5.50 from All Electronic Components, 118-122 Lonsdale St, Melbourne, 3000. Phone (03) 662 3506.

AMATEUR RADIO

BY GARRY CRATT, VK2YBX

Antenna tuners: why they are useful

If you browse through most catalogs of amateur equipment you will find a range of antenna tuners available for the amateur bands. Perhaps you may have had doubts about whether these devices are worthwhile. They are & this article explains why.

Possibly the most commonly considered theory regarding the benefit of antenna tuners is that they improve antenna efficiency and so assist in the effective radiation of signals by the antenna. In fact, nothing could be further from the truth. Antenna tuners do nothing to *improve* antenna efficiency but there certainly are other good reasons to use one.

These days, all modern transmitters are designed to operate into a nominal resonant 50Ω load. This is all very well in theory but in practice very few antennas present such an ideal impedance to the transmitter. In addition, solid state transmitters are designed so that their output power drops as the load SWR increases, to protect the final output stage from excessive dissipation which would occur when feeding a highly reactive load. So any antenna mismatch leads to increased SWR and therefore a subsequent reduction in radiated power.

For the VHF and UHF bands, the scale of resonant antennas is such that they can be made with quite manageable physical dimensions. They can also be made to provide relatively wide bandwidth, whilst maintaining a reasonable Q.

We know that any piece of wire connected to a transmitter will radiate signals to some degree, so it is logical that there will be a considerable advantage in using a device which assists in the matching of an HF antenna to the transmitter output stage, maximising the current flowing in the antenna, and thereby resulting in improved field strength.

A related factor to be considered is the Q, or "quality" factor of the antenna. Generally, RF experience indicates that the higher the Q, the better. However, this is not necessarily the preferred situation with HF antennas. A high Q means a narrow bandwidth and readjustment of the antenna tuning unit may be necessary, even for small changes in frequency.

For HF antennas, a low Q is preferred. As the Q of an antenna is determined by both the radiation and DC resistance, it may be preferable to select an antenna tuner where capacitive reactance is added to bring the antenna system to resonance, lowering the Q and generally giving broader bandwidth.

Most long wire or vertical HF antennas are loaded against ground and need to be only one quarter wavelength long at the resonant frequency. For an antenna tuner to assist in matching this type of antenna, it is important to have a good low impedance ground, so that equal currents can flow in both the antenna and ground, hence producing an antenna radiation pattern which will be of some use. If an insufficient ground is provided, an imbalance will exist, and the resultant radiation pattern will have (in the instance of a vertical) a high angle of radiation.

This heavy duty antenna tuner from Emtronics is based on the Pi network shown in Fig.3 but it also features monitoring of forward & reflected power via a twin needle meter to give SWR readings. It can handle HF band transmitters with output powers rated up to 1000 watts.

Measuring antenna current

A simple antenna current indicator can be made using a 25mm ferrite toroid slipped over the antenna wire.

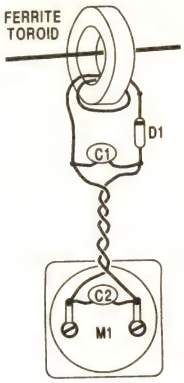


Fig.1: this circuit arrangement can be used to monitor the current flowing in a wire to an antenna or in the ground return. The two capacitors are each 100pF disc ceramics while the diode is any germanium type such as OA91. The meter is a 1mA movement.

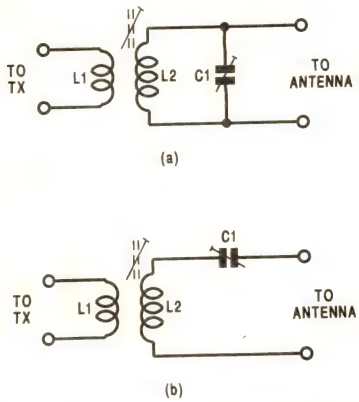
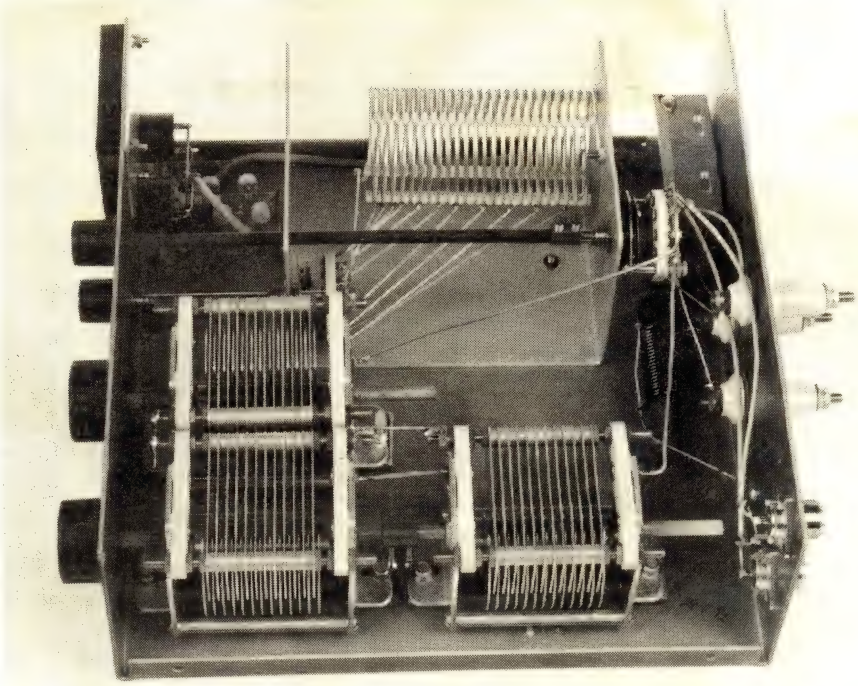


Fig.2: the simplest configuration for an antenna tuner, used to match a low impedance (50Ω) transmitter to a high impedance line is either a parallel (a) or series (b) tuned circuit, resonant at the operating frequency.

A pick up wire, comprising several turns around the toroid, feeds a diode and 100pF capacitor, wired to a 0-1mA meter which has a another 100pF capacitor across it. Fig.1 shows the circuit. By applying some RF energy from the transmitter and adjusting the antenna tuner, an increase in antenna current can be verified. The same circuit can be used in the ground lead, to verify current flowing.

The circuit configuration of an antenna tuner needed to transfer maximum power from the transmitter to the antenna depends to a large degree on the impedance of the feed line. The simplest configuration, used to match a low impedance, say 50Ω, transmitter to a high impedance line is either a series or parallel tuned circuit, resonant at the operating frequency. Fig.2 shows various configurations of series and parallel matching networks.



This photo shows the interior of the Emtron EAT-1000A antenna tuner. Note the wide spaced variable capacitors and the large tapped inductor.

A superior arrangement, based on the Pi network shown in Fig.3, allows 50Ω or so to be matched to an impedance of up to several thousand ohms. Both capacitors C1 and C2 are variable and, in a high power situation, must have widely spaced plates, due to the large amount of energy normally involved at HF. The inductor should be made from large diameter wire or copper tubing, to minimise insertion losses.

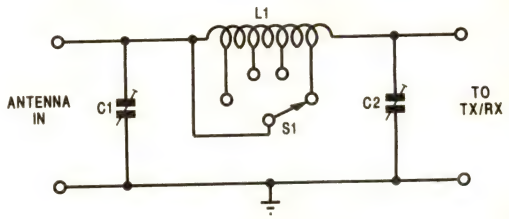


Fig.3: based on a Pi network, this antenna tuner allows 50Ω or so to be matched to an impedance of up to several thousand ohms. Both capacitors C1 & C2 are variable & are usually ganged together. The inductor should be made from large diameter wire or copper tubing, to minimise insertion losses.

A well designed Pi network antenna tuner should also include some form of gas discharge protection circuit, to prevent possible damage to the transmitter equipment from atmospheric discharge.

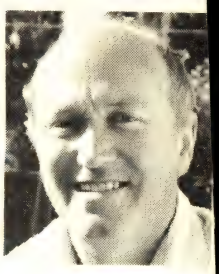
Some lower power designs use a tapped inductor to ensure a "match" across a wide range of impedances. In any case, the network is used to correct a mismatch problem and some reduction in system efficiency when compared to a correctly matched antenna at the same frequency will be noticed. However, this can still provide a major improvement over an unmatched antenna without a tuner!

Antenna tuners are also capable of making a noticeable improvement in received signal performance when a high impedance antenna, such as a long wire, is used with a low impedance receiver. The antenna tuner reduces the SWR by improving the antenna impedance matching, resulting in maximum transfer of energy. This is most noticeable when using a receiver without an RF stage, where the antenna input is fed via a bandpass filter to the mixer. In receivers having a high amount of RF gain in the first stage, the effect is not as noticeable.

In summary, an antenna tuner is no substitute for a properly designed resonant antenna, but in cases where such an antenna cannot be used, they can offer improved performance over an unmatched antenna system. **SC**

VINTAGE RADIO

By JOHN HILL



In the good ol' days of my childhood

Because radio receivers were expensive in the 1920s, many people built their own sets and even made the batteries to run them. In those days, it was a case of improvise or go without. We even built our own batteries.

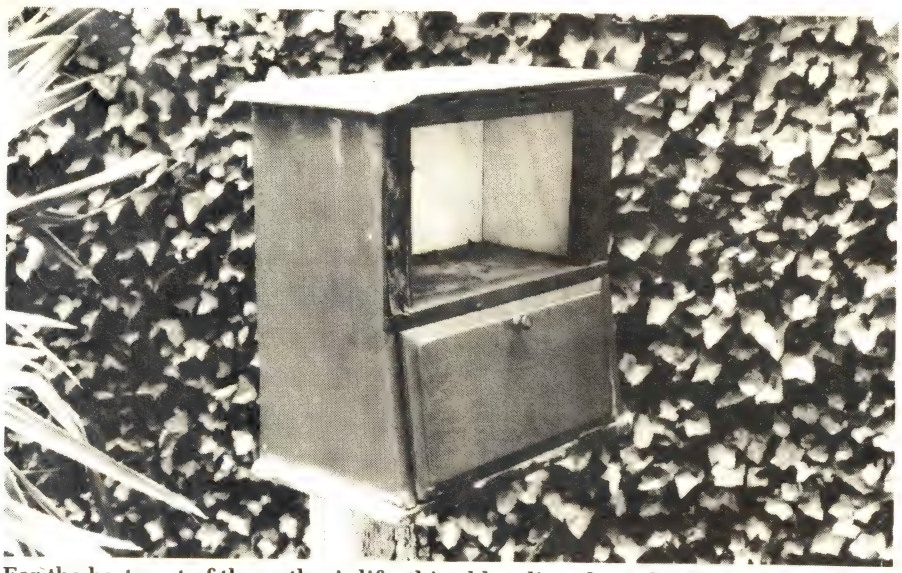
My interest in vintage radio started only eight years ago and I have learnt quite a lot in that time and enjoy my hobby immensely. However, it is not all new to me for there was a time in my childhood when I built crystal sets and often listened to these simple receivers until my callused ears could not tolerate the pressure of the headphones any longer.

I guess my early interest in radio rubbed off from my father. Dad was into radio in the early 1920s when about the only thing one could expect to hear was an occasional Morse signal from a distant transmitter. In those very early days of radio, there were not many stations on the air to listen to and those that were had quite limited transmission times.

My father was but a humble gardener in the 1920s and his wages were such that there was nothing left over from household expenses to spend on radios in any shape or form. Therefore, poor old Dad had to make his own equipment and, what's more, it worked.

Unfortunately, my father's homemade radio gear has now gone. It didn't seem important at the time so it all went to the tip when he died and although it may sound unkind, the tip was the right place for most of it. However, with my rekindled interest in radio today, some of Dad's homemade equipment would now be nice to have, if only for sentimental reasons.

I am convinced that few people today have the capacity to improvise as did those of yesteryear. Some of the projects my father tackled were incredible for a guy who left school at 13. That's another interesting thing about my father: he caddied at the local golf course for a year while his mother thought he was still going to school. God help me if I had tried that trick when I was 13.



For the best part of the author's life, this old radio cabinet has served to remind him of many exciting childhood activities. It sits on top of a post in the front yard and was where the billy was left for the milkman.

Crystal set

One of Dad's first radio projects was his crystal set. Now making a crystal set may not seem a very daunting task today but when my father made his, he had to make everything including the tuning capacitor and the crystal detector. The only item he purchased was a set of headphones, which gave excellent service for many years. In fact, I was still using them in the post-war years.

I remember the tuning capacitor quite well for it was used in some of my creations. I also remember that it was a bit stiff to turn and the old Emmco dial slipped when the shaft became tight at one end of the travel. I also recall that it should have had a few more plates in it, for it lacked sufficient capacitance to cover the full width of the broadcast band.

The crystal detector was made up from miscellaneous bits and pieces mounted on a small sheet of ebonite. However, the basic requirements were there. The crystal cup had three setscrews to retain the piece of crystal and the arm that held the cat's whisker

This Leclanche cell is similar to those used for the front gate bell. During the 1930s, the wet Leclanche cell was used almost exclusively for powering door bells.

was pivoted so as to give movement across the face of the crystal.

Home-made batteries

But those early achievements fade into insignificance when one thinks of Dad's home-made "B" batteries.

When I graduated from crystal sets to a 1-valve receiver, I was able to obtain a discarded B battery from the local tip. This battery kept me listening for a month or so but there soon came a time when it was no longer serviceable. Once again, good old Dad solved the problem by making a rechargeable 20-volt B battery.

Now this was no ordinary battery – in fact, few would recognise it as such.

It consisted of a wooden baseboard with 10 shallow holes bored into it. Placed into the holes were 10 small pill bottles – Doctor Morse's Pink Pills for Pale People if I remember correctly. These formed the cells of the battery and were three parts filled with dilute sulphuric acid.

Strips of sheet lead were used for the plates. These were shaped like an inverted "U" and arranged in the bottles so that the ends of each strip occupied two adjoining bottles. In other words, it was a very simple lead acid accumulator.

When placed on the battery charger (which used a home-made transformer and metal oxide rectifier), the lead plates changed colour almost immediately. The positive plates turned to a chocolate brown, while the negative plates went a light grey. However, because the battery charger could only produce about 12 volts, the battery had to be charged in two halves.

This 20-volt B supply kept the little 1-valver working quite happily, but after a couple of days it went strangely quiet. Reason – a flat B battery. Further testing indicated that the battery had almost no capacity. It could reach full charge in a matter of minutes and would discharge almost as rapidly. In fact, it could supply only about one milliamp of current for approximately 10 hours.

But although that miserable battery often went flat in the middle of an interesting program, it got me out of a tight spot at the time.

Making a rechargeable battery was nothing new to my father because he had made one once before. It lived under the house in a wooden crate and had been a source of mystery to me for many years. Apparently it was used way back in the days when part of Bendigo had a DC power supply (most likely from the tramway depot) and the battery was recharged by plugging it into the DC mains. During recharging, a globe was connected in series with the battery to provide the correct charge rate.

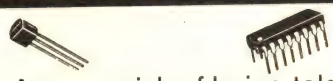
When my 1-valver subsequently grew into a 2-valver, the pill-bottle B battery was grossly inadequate; in fact, it was never even considered. It was time to crawl under the house and drag out Dad's old battery to see if it could be recommissioned.

Refurbishing an old relic

Once again, the old disused battery was a marvel. It was capable of supplying B voltages to the largest of battery receivers and was an impressive sight.

My father's perseverance never failed to amaze me. His B battery was entirely home-made, including the glass containers which housed each cell. These were made from small flat sided medicine bottles. The tops of the bottles had been cut off using the hot wire and quench method of glass cutting. It must have taken quite some time just to collect all the bottles and cut them to size!

COMPONENTS



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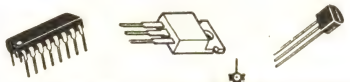

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The plates were also time consuming to make – no lead strips in this battery.

Each plate had been hand-cast in a special mould which shaped the plate with an open grid structure similar to that of a car battery plate. The respective lead compounds (red lead oxide for the positive plates and yellow lead oxide for the negative) were then hand-hammered into the plates.

The plates were installed two to a cell with a separator in between and held in place at the top with bees wax. The wax seal had a vent hole which also served as a top-up hole for distilled water or for checking the electrolyte with a hydrometer.

All things considered, a "helluva" lot of effort had gone into the making of this battery. However, the question at the time was could it be recommissioned to work my little 2-valve receiver?

Unfortunately, a quarter of a century spent in limbo under the house hadn't done the old battery much good. The electrolyte had not been drained before storage and the plates had sulphurated and were all white and horrible looking. What's more, many of the plates were starting to fall apart.

But it was not all bad news. After dismantling the whole battery, there seemed to be enough good plates to make up a reasonable size unit. And when the sulphurated plates were scrubbed up with a wire brush, the prospect of a "new" battery actually looked quite promising.

To cut a long story short, there were enough serviceable plates to make up a 40 volt B battery, with the leftover-plates being used to build a rechargeable A battery.

Battery charger

As previously mentioned, my father's battery charger could only charge at 12 volts, which made recharging a 40-volt battery a bit awkward. But good old Dad soon solved that problem.

A special switch was made consisting of a rotating drum with numerous brass contacts on it. The battery was wired to this switch in four 10-volt banks and the switch connected these banks either in series or parallel. This ingenious switch took the best part of a weekend to make and install.

The rechargeable batteries were a complete success and were used for several years. The B battery was put on charge every three months, while the A battery required attention at about 3-weekly intervals.

Leclanche battery

There were other special batteries used at home back in those distant days of my childhood. One of them was a wet cell Leclanche battery and it too lived under the house in a wooden box. This 3-cell battery powered the front gate bell and what a set up that was.

On the front gate was a home-made gate closer and combined switch. This switch closed its contacts when the gate was opened about six inches (sorry, but we didn't have millimetres back then). The switch was connected to the battery by underground cables which were laid before the front lawn was planted more than 60 years ago. The cable then ran from the battery to an electric bell in the kitchen.

When the gate was opened, the bell gave a short ring and then another short ring when it closed. This switching arrangement prevented the bell from ringing continuously if someone held the gate open for a prolonged period. For reasons unknown, the bell was later changed to a buzzer.

The bell always gave a warning when someone came through the front gate and by looking into the strategically placed mirror outside the dining room window, the "intruder" could be observed walking down the garden path. Now I ask you – who needs expensive modern electronic surveillance equipment? Just consider the small cost and effectiveness of this old style system.

I'm sure that my father was never involved in any underhand activities but he sure had a suspicious nature, particularly where strangers were concerned.

Actually, the gate bell did detect the presence of a few undesirables. In those days, stealing milk money was commonplace and several would-be milk money snatchers were met halfway across the front lawn. As Dad was a fairly good boxer in his day, the trespasser usually got a straight right to the jaw if he didn't beat a hasty retreat.

This gate bell early warning system also had its problems, such as on those occasions when Dad had forgotten that I had gone out to a picture show. We

ad several confrontations in the middle of the front lawn at midnight!

The problem was solved by developing a special gate opening technique. If the gate was zapped open quickly and then zapped closed again, the old bell didn't have time to get into the swing of things and I was able to sneak in (or out) at any hour – undetected.

A horsey story

Still another battery was used at home for a while and this one was installed in the workshed. At the time, my older brother was interested in electroplating and he required a DC supply for his experiments, hence the need for still another battery. In this case, it was a 3-cell potassium bi-chromate battery.

This battery was bought in kit form from Selbys and when assembled used large glass jars to hold the potassium bi-chromate and sulphuric acid electrolyte. When not in use, the plates (zinc and carbon) had to be lifted out of the solution to protect the zinc plates.

As I recall, the electroplating experiments were far from successful. However, it was not the fault of the battery. Electroplating is a specialised process which requires special techniques. Unfortunately, these were never learnt.

The bi-chromate battery did find another use, however. Its 6-volt output was used to drive an old T-model Ford ignition coil (the trembler type). The most spectacular experiment with this equipment by far involved the electrification of the back fence.

Our neighbour at the back had a horse which kept scratching itself on the fence and, in the process, had just about flattened the rickety structure. The fence was re-erected and steel wire was woven throughout the weather-beaten palings to help hold things together. The final touch to the fence repair was to connect the old Ford coil to the wire reinforcement (with an earth return) and wait for the horse to come back for another scratch.

The electric fence equipment was installed in the shed, complete with a peep hole drilled in the rear wall for observation purposes. The primary of the Ford coil was wired to the battery via a Morse key switch.

Eventually the horse returned for a rub up along the fence and Dad gave him a quick zap. Neddy must have backed away at the crucial moment and only got a bit of tickle. But the second time around he had his nose on the wire when the switch was closed. He never went near that fence again.

Part of the potassium bi-chromate battery still survives. One and a half zinc plates still remain and I solder odd pieces of these plates to my car radiator cap as sacrificial anodes. The zinc protects the aluminium cylinder head and other alloy components.

The only other thing that remains to remind me of all this childhood excitement is an old 1920s battery radio cabinet. It stands on a wooden post beside the garden path where it has stood for the last 40 years or so. However, the reason for the old cabinet's strange and elevated position is no longer apparent. It was where the billy was left out for the milkman who once called in the early hours of the morning. Remember the days of free home deliveries?

No doubt, lack of funds was one of the reasons my father made so many of the things he couldn't afford to buy. He grew up in difficult times and worked hard all of his life. Nevertheless, he still found time and a little money to follow his hobbies and special interests.

Radio and electronics have developed to such a degree today that everything has become too "high-tech" for the average person to handle. Whereas my father and those like him used to build their own equipment, the situation now is entirely different. In my opinion, all the fun has gone out of electronics and the hobbyist has been reduced to assembling kits if he is inclined to do so.

That's one of the reasons I like vintage radio restoration for it is still a hands-on, do-it-yourself activity that appeals to me in particular. The almost total lack of vintage components encourages one to improvise and scrounge. Such a pastime can be a lot of fun.

My current interest in old radios helps to remind me of a time when the style of life and the activities people pursued were a good deal different from the lifestyles of today. I am also glad that I spent my childhood during those times and if I had to choose again, I'm sure I would follow the same path. **SC**

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Suggestions for the 2kW inverter

This letter is a collection of ideas for projects that came to me after seeing John Clarke's excellent project on the 2kW Sinewave Inverter. This is one of the best and most interesting projects I have seen for some time.

No doubt you have had plenty of people suggesting an auto-start facility on this inverter (essential for a normal size stand-alone system), so I would like to add that a 500VA unit would probably attract even more interest.

First project idea – a circuit board which contains the essential components of a universal switchmode DC-DC converter; ie, if one wants to go from 12-32 VDC to the same kind of range on the output, one puts the appropriate size chokes, capacitors and other components in the appropriate place on the board.

Second idea – there are countless thousands of square-wave output inverters in place around Australia, so is there some way say, of rectifying the output of same and then converting this DC to sine wave. Possible?

Finally, how about a design for a system to convert 12/24V to 110V DC and back down again? The reason for this is that there are a lot of stand-alone 12/24V systems which need to supply power over some distance. A typical situation is where solar panels need to be located some distance from the storage batteries. Converting to 110V and then back down again would save on transmission losses and, in many cases, the cost saving in copper wire would outweigh the cost of the electronics.

Needless to say, my house runs off low voltage DC (24V).

In the February 1991 issue, you had an inverter design for fluorescent lamps. Would it be possible to give more information on using these inverters with the new hybrid fluorescent tubes as they are definitely more efficient? And how about some suggestions for reducing RFI, a big problem for DC power fluoros? (D. A., Kyogle, NSW).

• In general, we don't think a 500VA version of the 2kW sinewave inverter would be really practical since its overall cost is not likely to be substantially less than the 2kW design. You really do need the grunt of the big design in order to reliably start such appliances as refrigerators and power tools.

We're not sure what point there would be in a universal DC converter as you suggest. If it was truly universal, it would not need any component changes and you would merely change the feedback to select the output voltage. But again, what would be its purpose?

All those square wave inverters could be rectified as you say and the resulting DC converted to AC. However, the resulting efficiency would be poor. Let's face it, for many applications, a square-wave 240VAC inverter is quite adequate. Why go for a more complicated circuit to get no working improvement?

Finally, and we seem to be knocking all your suggestions, the idea for stepping up 12V or 24V to 110VAC and then back down again to reduce cable costs and losses is problematic. You would have to take into account the cost of electronic components at both ends plus the transformers. There would inevitably be a significant reduction in efficiency.

One method to reduce the cost of cable would be to use the Earth as one side of the circuit. There is nothing new about this and it is still used in DC systems. You just have an earthed metal stake at either end of the system and just run one cable for the positive lead. The only drawback is the risk of corrosion in the earth connections at either end.

It is doubtful whether the new hybrid fluorescent lamps with solid-state ballasts are appreciably more efficient than conventional fluorescent lamps and they certainly don't have the same life expectancy. However, if a conventional fluorescent tube is run with an electronic ballast, there is an improvement in efficiency. The inverters described in our February 1991 issue will drive the new compact fluorescent tubes, without the solid state ballasts (ie, the circuitry in the lamp base) being necessary. However, you will get more light out of a conventional tube of equivalent power rating. It will be cheaper too.

High voltage, high current meter wanted

I have a small problem in that I have been unsuccessful in finding simple digital volt meters that are capable of measuring from 0V-20V and 0V-2kV, with more emphasis on the first range. I have also been unsuccessful in finding digital current meters that will cover the range (1) 0A-100A and (2) 0A-2kA, again with more emphasis on the first. I wish to run both volt and amp meters at the same time, so switching from one to the other would be inappropriate. (D. C., Dunedin, NZ).

• We published a 3½-digit LCD panel meter in the September 1992 issue of SILICON CHIP. As presented, this could be made to read up to 200V DC and 2A DC.

It could also be made to measure to 2kV, provided the voltage multiplier string of resistors had a sufficiently high voltage rating. However, it would not be practical to make it read up to 100 amps or 2,000 amps because the necessary shunts would have vanishingly low resistance.

The only practical way to measure such high currents is to use a DC clamp meter. These are readily available but they are not cheap.

Suppressing the RFI (radio frequency interference) from fluorescent tubes is very difficult whether or not they are driven by inverters. The problem is that the gas discharge inside the fluorescent tube itself is the source of the electrical noise. Connecting a small high voltage ceramic capacitor (say 0.0047μF 3kV) directly across the tube can help but you really need to surround the tube itself with a grounded metal mesh to make any useful reduction in the radiated interference.

Combating interference in hifi systems

Do you have a circuit diagram for a mains filter and high voltage protection device solely for stereo hifi? The only kit I could find is the "Mains Muzzler" (published in January 1989) which is intended for computers. With hifi, more care should be taken about which frequencies are suppressed. There are mains filter/protectors available for hifi but they are extremely expensive for some reason. A hard-wired device would be preferable to one using a circuit board. Hoping you can assist. (P. W., Paraburdoo, WA).

• The only project we have published along these lines is the "Mains Muzzler". While it was promoted as being suitable for computers, it could also be used for hifi systems. However, in our experience, mains filters for hifi systems seldom have much effect. This is because the interference usually comes in via the signal leads or the loudspeaker leads, not via the mains supply.

The most likely source for the interference is via the loudspeaker leads. This can easily be confirmed by disconnecting the loudspeaker leads and listening to your system on headphones. If the system is free of interference in this mode, then the interference is definitely coming in via the speaker leads. The easy solution in this case is to wind both sets of speaker leads at least five times through a large diameter iron dust toroid (available at outlets like Jaycar and Dick Smith Electronics).

On the other hand, if the interference is entering via the signal leads, there is seldom anything you can do short of modifying the internal circuitry of the offending piece of equipment. Most people are unable or unwilling to do this and, therefore, it is a problem that many people have to live with.

Increasing the output of a 3-terminal regulator

I want to know about the possibility of paralleling two TIP2955s as pass transistors with a 3-terminal regulator to increase the available current to above 4A. Could you please tell me what approximate current this arrangement would achieve if properly heatsunk? Would both transistors share the same 3.3Ω feed resistor, if its rating is increased from 1W to 2W? What other resistors or components would be required to parallel them so that they equally share the current?

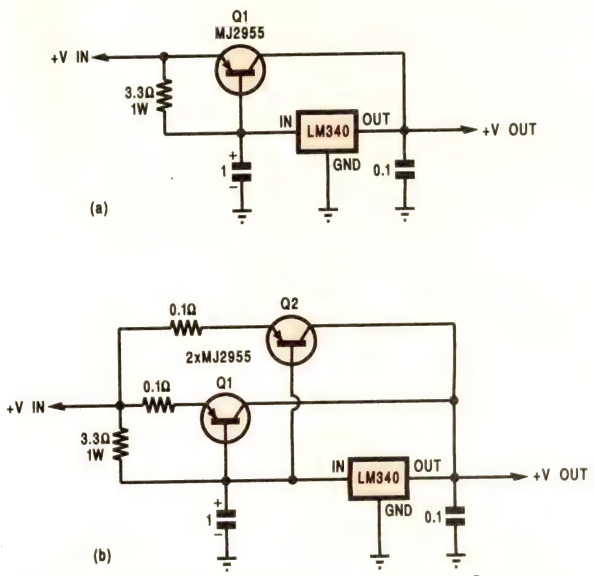

Fig.1(a) allows a standard 3-terminal regulator to deliver up to 5A, while Fig.1(b) allows two transistors to deliver a total of 8-9A.

Finally, could you explain the working principle of electric earth leakage units that are used for protection against electrocution? (L. B., Tin Can Bay, Qld).

• If you want more current from a 3-terminal regulator, the standard booster circuit shown in Fig.1(a) can deliver 5A. If you want to use two MJ2955s for even more current, say up to 8A or 9A, the circuit of Fig.1(b) shows you how. Note that you don't need another 3.3Ω resistor but you do need a 0.1Ω resistor for each transistor, to make sure they share the current equally.

Earth leakage circuit breakers work by comparing the amount of current flowing in the Active and Neutral wires of the mains supply in a circuit. The Active and Neutral wires are both wound several times through a toroidal core. If both currents are exact, as they normally will be, there will be no magnetic flux set up in the core. If there is a slight imbalance between the Active and Neutral currents, as would happen if there was a leakage current to earth, then the resulting magnetic flux in the toroidal core generates a voltage in a third winding and this is used to trip a circuit breaker.

Earth leakage circuit breakers of this type are sometimes referred to as "core balance relays" and as you can see from the above description, this latter name better describes their mode of operation.

Resistor burn-out in power amplifier

I have a problem with the 120W PA Amplifier featured in the issues of November, December 1988 and January 1989. Basically, my problem is that the three 12Ω 1W resistors in the output burn out. It does not happen immediately upon switch on but after about two hours of operation, they go up in smoke. Also the amplifier does not appear to have its full 120W of output when compared to another 60W amplifier.

I have measured all the voltages and they appear to be spot on. I have changed the output transistors, thinking that this may cure the problem but to no avail. When the resistors burn

Life, lawns & the Woofer Stopper

Your Woofer Stopper in the May 1993 issue gives me renewed hope and I certainly intend obtaining one. However, my main trouble with "mutts" and "moggies" is their nocturnal fouling of lawns and gardens.

Some time ago I installed a passive IR floodlight unit primarily as a safety device, but find that it readily detects and to some extent scares animals bent on messing up the place. This in combination with a slightly modified Woofer Stopper should completely overcome the problem.

My thoughts are: (1) since the flood unit has an adjustable timer (a few seconds to 15 minutes), it should be possible to delete the Woofer Stopper timing function and switch it on/off with the floodlights; (2) Power a small PSU from the 240V at the lamps (easily accessible) to provide a suitable common DC supply for the modified circuitry. The flood unit is rated 300W maximum – I use two 100W lamps.

There must be many garden enthusiasts who would appreciate such a gadget. Would you please consider publishing a modified circuit and description of such a unit? (A. B., Chittaway Bay, NSW).

• There is no reason why the system would not work (technically) but whether it would stop dogs defacing your lawn we do not know. If the idea receives sufficient reader interest, we shall consider a version along the lines you suggest.

out, the amplifier has been loaded with a total of about 60W in speakers (to the 100V line outputs).

Something that seems odd with the design in that you say the amplifier output should be loaded with an output transformer that presents a 4Ω load, but on checking the data in the Altronics catalog, the wiring configuration you suggest gives a 16Ω load. Could this be the problem? (D. W., East Gresford, NSW).

• We think the most likely reason why the output resistors are burning out is that the 4.3µH inductor in parallel with those resistors is open circuit. That would explain why it takes an hour or two for the resistors to fail and also why your amplifier does not appear to be delivering full power.

You can easily check whether the inductor is open circuit (or not properly soldered into circuit) by measuring across the three paralleled 12Ω resistors with your multimeter. The reading should be zero ohms but if it reads four ohms, then the inductor is open circuit.

You are not the first person to be confused by the data in the Altronics catalog. The data is incorrect. The transformer should be connected as indicated in the circuit on page 28 of the December 1988 issue; ie, with primary windings in series and the secondary windings in series. That connection "reflects" a load of close to 4Ω to the amplifier's output and allows it to deliver maximum power.

Building the FM subcarrier adaptor

I wish to build the FM Radio Receiver described in the November 1992 issue of SILICON CHIP. In doing so, I wish to add on a subcarrier adaptor circuit detailed recently in another electronics magazine. This will allow me to receive the increasing number of ACS (known as SCA in the USA) transmissions being piggy-backed onto the FM broadcasts in our capital cities, in the subcarrier range of 67-92kHz.

However, I have a slight problem in that the adaptor circuit I have states that it should be connected to the FM receiver's detector output, straight after the discriminator but before any filtering and obviously before the stereo decoder. The article further suggests that this point could be found (in the event that you lack a circuit diagram for the radio) by looking for audio signals in the high frequency range around 50kHz near the discriminator IC or coil, with a level of around a 100mV or so.

It doesn't seem to matter whether this signal has some DC present as it is AC coupled at the input of the adaptor. This sounds fine if you happen to have a CRO but I don't and also don't want to go out and buy your circuit and the adaptor only to find that it will not work. Can you suggest the ideal point to get these signals for the adaptor on the FM Receiver you described in the November article?

Having described my problem, you might like to know that the adaptor in question requires a fair amount of basic construction and I am not aware of any kit resellers that intend to sell this kit complete. This brings up another point. Would SILICON CHIP be interested in producing a full ACS FM receiver in a future issue? An FM receiver along the lines of the November 1992 circuit, modified so that it could receive ACS or normal FM broadcasts at the flick of a switch, would be great. What would the readers think of this?

I believe that you produced a subcarrier adaptor back in January 1988 but I don't have the article and besides no-one that I am aware of produces the kits. I've also heard that it requires a slight modification to its twin-T filter circuit capacitors in order to receive signals such as the BBC, etc. Wouldn't it be great to combine an FM receiver and the adaptor all in one? (P. F., Camberwell, Vic).

• The FM Receiver described in our November 1992 can be used as a source for the SCA adaptor, as you suggest. Just take the output directly from pin 2 of IC1. The SCA adaptor we described in January 1988 is no longer available in kit form but the parts are readily available, including the PC board.

It is quite simple to modify it to suit the BBC signals. All you have to do is change the capacitors in the twin-T filter from 0.0022µF to 0.0015µF. No other changes to the circuit should be necessary.

Notes & errata

Nicad Cell Discharger, May 1993: transistor Q2 is incorrectly labelled on the circuit diagram (Fig.1) as a BC328. It should be a BC338 NPN type, as shown in the parts list. The parts list should also be amended to show 1 x 2.7kΩ resistor and 2 x 1.5kΩ (not 1 x 1.5kΩ) resistors. **SC**

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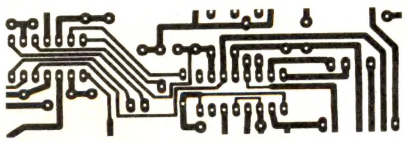

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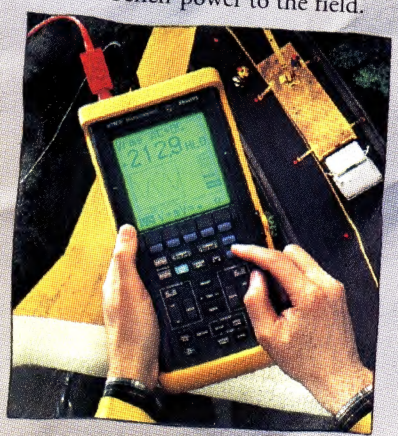

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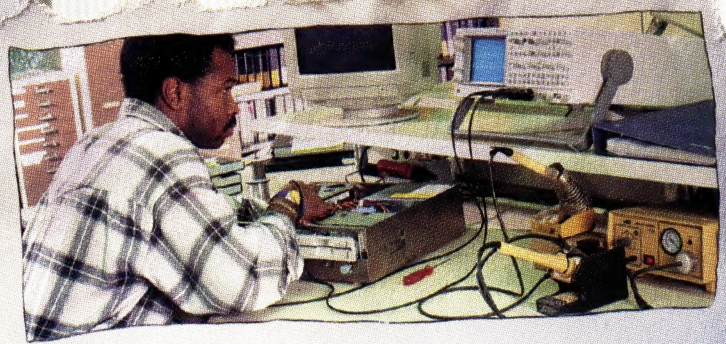

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